Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING • FIVE DOLLARS A YEAR

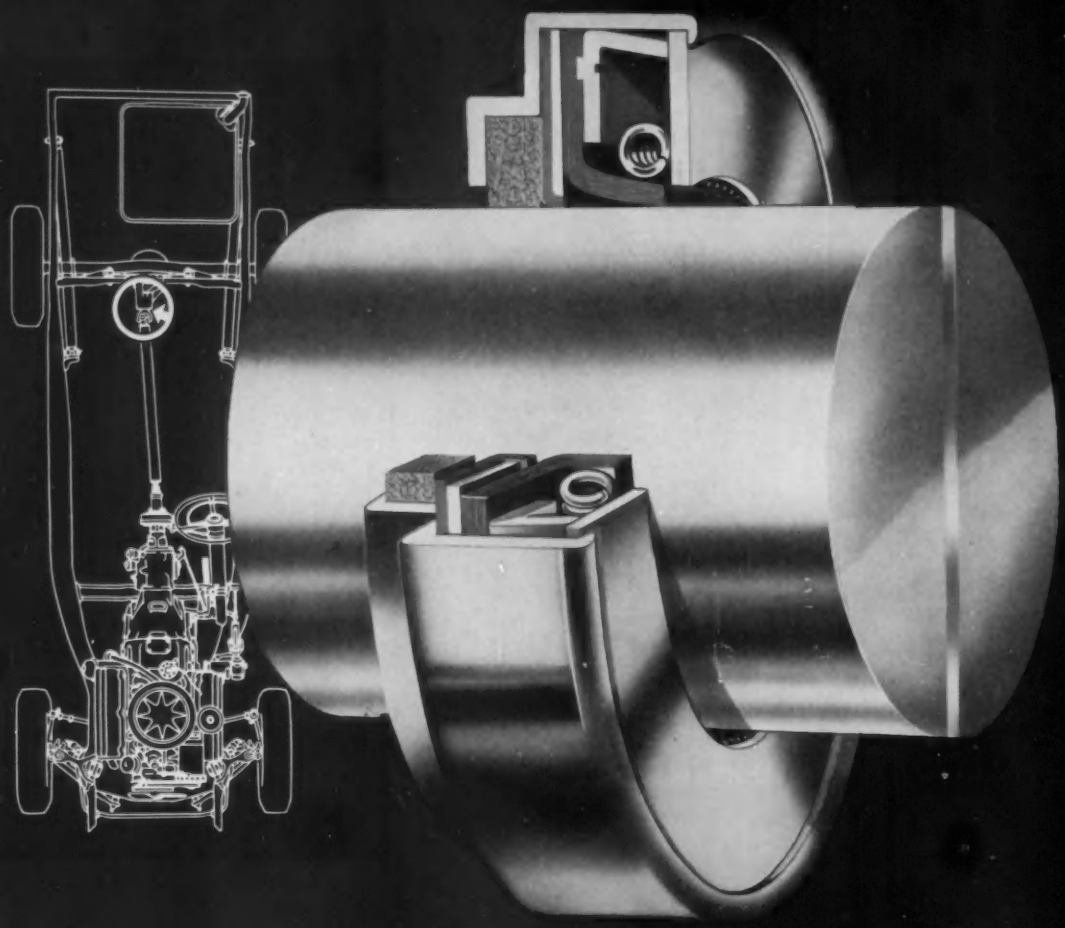
Pouring An Alloy Steel Centrifugal Casting

MAY 1954

Alloy Steel Castings • *Thermostatic Controls* • *Reinforced Plastics*

Annealed Gray Iron Castings • *Forced-Torque Drives* • *Treated Felts*

Nonlinear Techniques in Design • *Movable and Fixed Core Motion Transducers*



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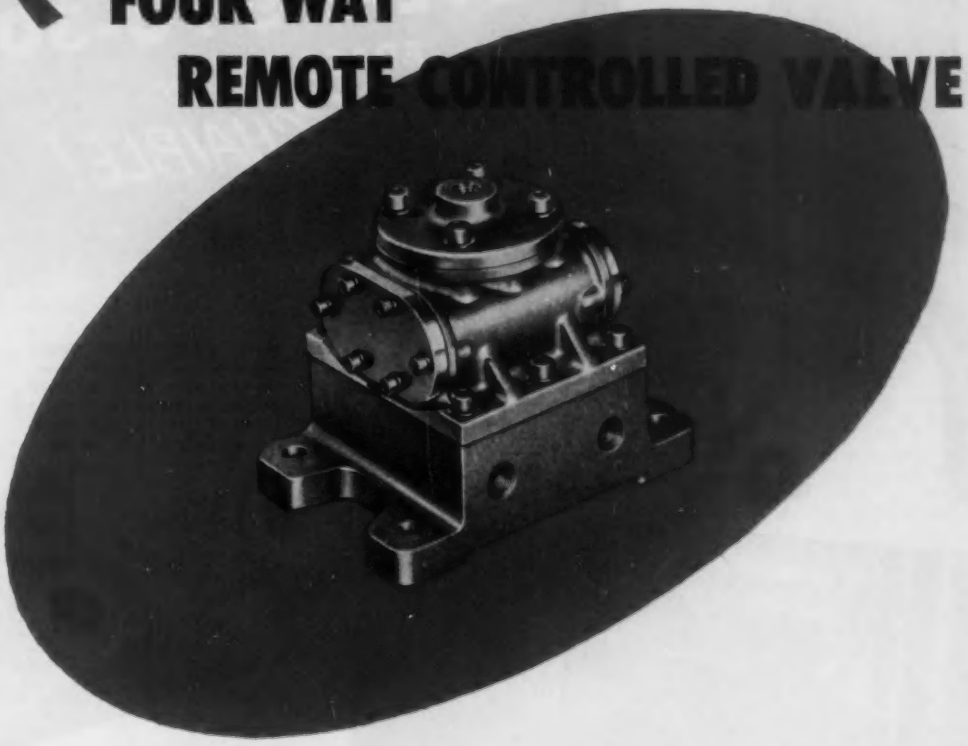

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The Schaible Company has made more than one million spouts by this new method without a single field performance failure—better spouts, states Schaible, produced by more economical means than conventional casting methods.

Today, there may be more costly spouts, but according to Schaible "There is no better spout than the Schaible Hydramold formed spout."

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THIS MONTH'S COVER

Centrifugal casting department at Lebanon Steel Foundry. In the foreground, alloy steel is poured into a spinning mold. In the background is a finished ring being cooled in air. The Centri-Die system uses centrifugal force and a metal mold to form a very dense product. See page 129 for the recommended approach to casting problems.

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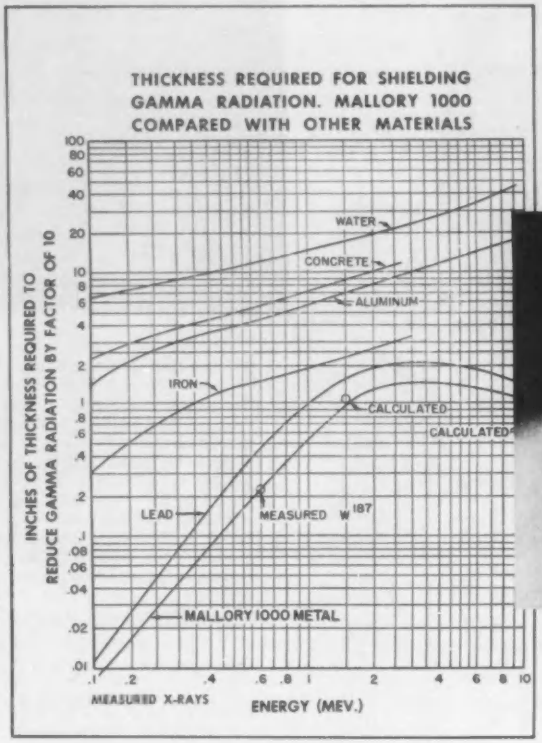
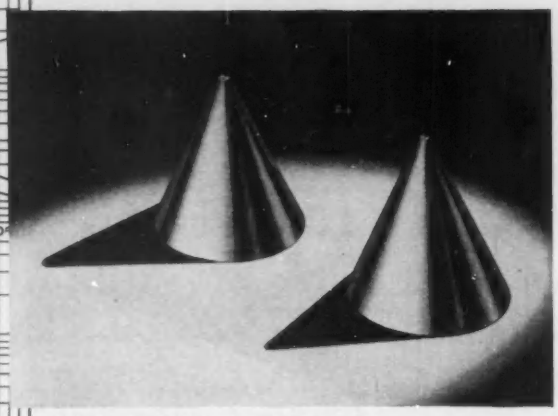
Mallory 1000 Metal...

An Effective Answer for Radioactive Shielding





Mallory 1000 Metal is a high-density, homogeneous alloy of tungsten, nickel and copper fabricated by special powder metallurgy methods that make it especially well suited for use as an effective radiation shielding material.

Recently, samples of Mallory 1000 were placed in the atomic pile at Oak Ridge, Tennessee, along with control samples of pure tungsten, nickel-tungsten and copper-tungsten. After being subjected to a high neutron flux density for four weeks, preliminary measurements indicated two primary radiation products: tungsten (187) with a 24-hour half life and tungsten (185) with a 74-day half life. Relative radiation intensity of the samples now, several months after removal from the pile, represents a tolerable time of more than 8 hours at working distances of 3 inches.

High voltage X-ray absorption tests have proved Mallory 1000 to have about 20% better absorption properties than lead when used as a shield for 100 MEV X-rays from a Betatron.

All the tests run by our physicists, engineers and metallurgists indicate Mallory 1000 to be suitable for use as containers for radioactive isotope storage. It is also a good shielding material for Betatron, Synchrotron and Cyclotron radiation.

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For complete information on Mallory 1000 Metal, write to Metals and Ceramics Division, P. R. Mallory & Co. Inc., Indianapolis, Indiana.

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For information on titanium developments, contact Mallory-Sharon Titanium Corp., Niles, Ohio

Highlights

When requesting further information from companies and organizations mentioned in the items below, confusion can be avoided by referring to the issue of Product Engineering in which items appear.

Current research and design developments soon to influence product engineering.

NONMETALLIC MATERIALS

. . . . A new synthetic elastomer foam, which is said to be resistant to fire and deterioration from sunlight, oil and grease, has been developed by the Research and Development Laboratories of The Goodyear Tire and Rubber Co., 1144 E. Market St., Akron 16, Ohio. The synthetic composition provides a product of higher compression and lower weight than does natural rubber, and has inherently higher tensile strength with similar porosity. Compression can range from very soft to very firm. Texture: from silky fine to a rough, coarse material.

POLYETHYLENE STRENGTHENED. . . .

. . . . Irradiation by means of high energy electrons in a nitrogen atmosphere has strengthened and increased the elasticity of polyethylene plastic material. Scientists at the General Electric Research Laboratory, One River Road, Schenectady 5, New York, report that the irradiated polyethylene stretched as much as 450 percent without breaking. When the tension was relieved the plastic returned to its original shape. Also, steam sterilization caused the collapse of untreated shapes, while irradiated shapes were relatively unaffected by the high heat of sterilization.

CERAMIC PAINT. . . .

. . . . Ceramic fireproofing paint can be sprayed on in coatings as thin as 0.001 in. and for limited periods can withstand temperatures up to 3,500 F. This may be another answer to high temperature jet flame, says Ryan Aeronautical Co.'s Development Laboratory, 2701 Harbor Drive, San Diego, Calif. And they add that the paint may permit normal engine operating temperatures to be boosted 150 F. The paint is a ceramic-metal mixture of nickel-magnesia powder. Other combinations are being developed.

HIGH IMPACT THERMOPLASTIC. . . .

. . . . A new resin, described as ideal for milling, calenderizing, extruding, injection molding and forming, is being made in pilot plant quantities by The Marbon Corp., 1926 W. 10th St., Gary, Indiana. The plastic is said to have the toughness of rubber, the surface hardness of most metals, and be highly resistant to shock and heat. Markets cited for the material include molded fittings, automotive equipment, electrical fixtures, control gears and process equipment. Another interesting factor: it can be used with existing mold machinery. This permits a changeover of resin without increasing fabricator costs.

NEW TYPE RUBBER. . . .

. . . . A synthetic rubber, which is claimed to have properties not found in other rubber products, has been developed through cooperative research by the Office of the Quartermaster General, Department of the Army, and the M. W. Kellogg Co., Danforth Ave., Jersey City, New Jersey. The material is said to be non-flammable, tough, and abrasion and heat resistant. Temperature range is −15 to 400 F. Applications include fuel hose, diaphragms, gaskets, seals, tank liners and other similar components.

METALLIC MATERIALS

. . . . Superior new plastics, jet fuels and other new products will be made from boron in the future. So says a scientist at the University of Southern California, University Park, Los Angeles, California, who reports that boron-containing polymers have taken temperatures to 650 F without decomposition and so have a potential use in application where heat resistance is important. Some boron compounds, such as diborane and aluminum borohydride, have already been considered as possible high-energy jet fuels.

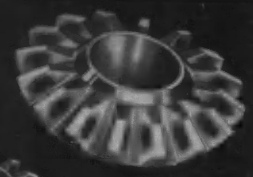
HIGH STRENGTH POWDER METAL. . . .

. . . . Molded parts are now being produced—with a new powder—that possess physical characteristics heretofore obtainable only in wrought steels. Keystone Carbon Co., 1935 State St., St. Marys, Penna., reports an ultimate tensile strength of heat treated parts of 115,000 psi, with hardness values of Rc 30. Powder metal parts, such as gears, cams and rollers, can now be designed, it is stated, for heavy duty service.

HIGH TEMPERATURE CARBIDE. . . .

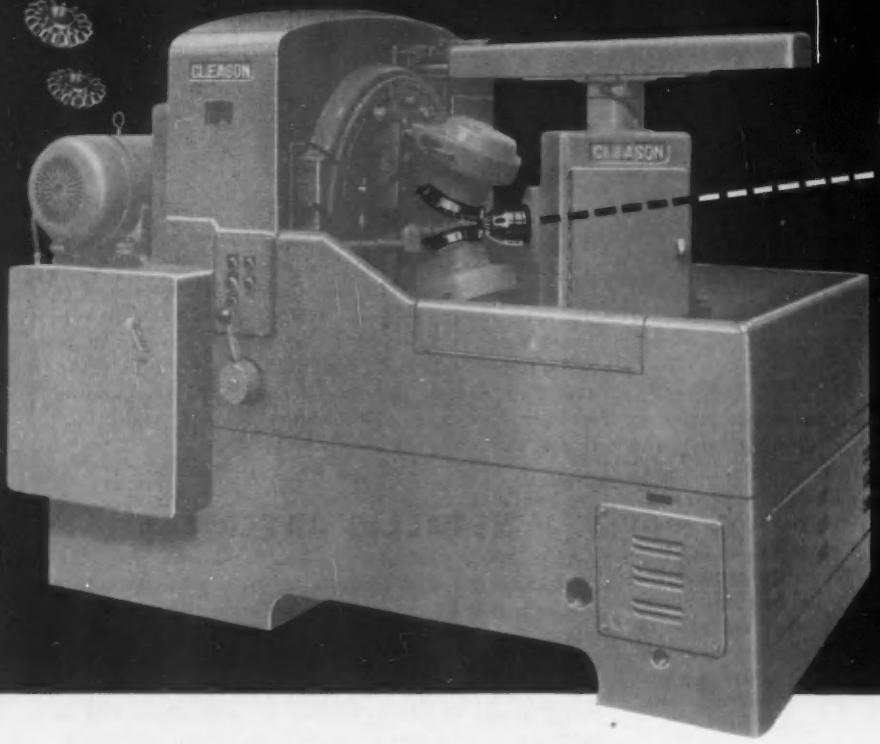
. . . . The power of jet engines may be tripled through use of a new metal called Kentanium. Kennametal Inc., 700 Lloyd Ave., Latrobe, Penna., reports that the

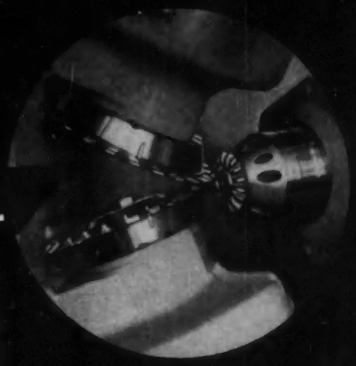
(*continued on page 7*)



for the first time . . .

CONIFLEX Gears* in one operation!





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material exhibits high strength at 2,000 F—about 500 F hotter than the working temperature of some of the super alloys. The metal is made principally of titanium carbide, with small percentages of tantalum and columbium carbide mixed in. Nickel is used as a binder. Some compositions have even withstood brief exposures to temperatures as high as 4,500 Fahrenheit.

NICKEL SAVING. . . .

. . . . By using an HF grade alloy for castings to be used in the temperature range of 1,200-1,600 F, a substantial saving of nickel can be realized. Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio, has reached this conclusion after 30 months of research sponsored by the Alloy Casting Institute. The recommended alloy should contain about 20 percent chromium and 9 percent nickel, as compared to the 26 percent chromium and 12 percent nickel of the previous used HH grade of casting material.

NON-CRITICAL HEAT-RESISTANT ALLOY. . . .

. . . . An alloy composed of iron and aluminum, with small quantities of vanadium or columbium as alloying material, has opened a whole new field to the metallurgist. Naval Ordnance Laboratory, White Oak, Maryland, reports the metal is lightweight, resistant to heat and corrosion, retains much of its strength at high temperatures, yet requires no critical material. At the present time the metal offers possibilities in the fields of engine exhaust systems and heating-element filaments where heat is troublesome.

TESTING

. . . . A portable thermo-electric metal comparator, which can be used to sort mixed metals, either ferrous or non-ferrous, is being used by the General Motors Corp., General Motors Bldg., Detroit 2, Michigan. The principle: two dissimilar metals in contact will generate an electromotive force that varies with the junction temperature and the material. Another possibility: the comparator can also be used to measure the thickness of electroplated finishes.

RIVETING ALUMINUM. . . .

. . . . Five years of laboratory experiments have now culminated in the fabrication of riveted light alloy structures of large size. The Aluminum Development Association, 33 Grosvenor Street, London, W.1, England, reports that current applications include bridges, monotower cranes, and similar structures. Rivets used are a hot-driven ¾ in. dia and a cold-driven ⅞ in. dia (the latter for highly stressed connections). The ¾ in. rivet develops a minimum shear stress of 24,640 pounds per sq inch, while the cold-driven rivet develops a minimum value of 29,120 pounds per sq inch.

ETCHING TITANIUM ALLOY. . . .

. . . . It has been found in the course of phase diagram work on titanium alloys that metallographic identification of phases by the usual etching techniques does not always yield positive results. Work done at New York University, University Heights, New York 53, New York, under a Bureau of Aeronautics and a Watertown Arsenal Ordnance contract illustrates a new method. A cumulative etching technique is used; the surface is electrolytically etched for a fraction of a second 5 to 10 times. This develops the structure sufficiently for positive identification.

NON-RUSTING IRON CRYSTALS. . . .

. . . . Laboratory experiments have achieved iron crystals in the form of whiskers a thousandth of an inch thick and about one in. long. General Electric Research Laboratory, One River Road, Schenectady 5, New York, states that the crystals prove theoretical calculations that indicated a pure iron crystal, one in. sq, could hold up a million lb. It is believed the perfection in atomic structure in the crystals gives them the strength and anti-rusting qualities.

SUBZERO TEMPERATURE TESTS. . . .

. . . . In an effort to discover the properties of commercial wrought and cast beryllium copper at subzero temperatures, a two year test program has just been finished at the University of Pennsylvania. Sponsored by The Beryllium Corp., Tuckerton Road, Reading, Pa., the tests were conducted from zero to —300 F. Properties tested were tensile and impact strengths, elongation and elastic modulus. Results: beryllium copper performs with unhampered and even heightened efficiency under subzero conditions.

COMPONENTS

. . . . Stability in a transistor has been achieved by use of stabilized germanium, a development that involves special treatment of the material, according to the Sylvania Electric Products, Inc., Electronics Division, Woburn, Massachusetts. And, says Sylvania, the development of germanium-silicon alloys will permit transistors to operate effectively at high heat levels. With stability and long life at high temperatures

(*continued on page 9*)

LESSON IN STAYING PUT

and Bonderite Makes Paint Stay Put on Metal

Paint doesn't stay put when applied to raw metal surfaces. But the same metal, treated with Bonderite, holds paint firmly.

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assured, the company believes the units will be used in ever increasing numbers to reduce equipment size and costs in military and commercial applications.

NEW MOUNTS....

. . . . Longer life and reduced maintenance costs on such installations as aircraft cowls are forecast with a new center-bonded mounting. Lord Manufacturing Co., 1639 West 12th St., Erie, Penna., reports that the rubber is bonded securely to the center sleeve and precompressed inside the outer sleeve. This is claimed to relieve tension fatigue encountered with high radial loading. Ends of outer member are rolled over to insure against the possibility of slippage.

TINY MOTORS....

. . . . A 1/400 hp miniature permanent magnet motor that has application for small fans, blowers and similar lightweight load items is a new development of the Dalmotor Co., 1375 Clay Street, Santa Clara, Calif. Total weight is 5 oz. Designed for continuous duty, the motor draws 0.18 amp at 27 v d-c. Special lengths and arrangements—including splines and gears —can be provided for the $\frac{1}{8}$ in. dia shaft.

SMALL LAMP....

. . . . A neon glow lamp, only 1/20 of an in. in dia, produces a 1/40 of a watt glow claim engineers at the Westinghouse Electric Lamp Div., Watessing Center, Bloomfield, New Jersey. The unit, which can be powered by hearing aid batteries, is used as an aid in timing photographic records of missiles and can also be utilized for similar camera work in laboratories where space is at a premium.

MEASURING GAGE....

. . . . A machine that, it is claimed, can measure accurately to within 1/10,000 of an inch is being used by the General Electric Co., One River Road, Schenectady 5, New York. It is being used to check on master gages, master gears and measuring rods employed by the company for inspection and development work.

GENERATOR....

. . . . A new 100,000 kw turbo generator has recently been installed at Niagara Mohawk Power Corp.'s Huntley station, Buffalo, New York. Built by the Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Penna., the unit is reported to be only slightly larger than the average 40,000 kw machine.

PROCESSES

. . . . A primer that is applied directly over rusts and stops rust action is a development of the Rusticide Products Co., 3125 Perkins Avenue, Cleveland 14, Ohio. When applied to rusted surfaces it causes iron oxide to change chemically to iron phosphate. When dry, rust action is stopped, and the paint attaches itself so tightly that moisture and oxygen cannot attack the metal. Sandblasting and flame cleaning are claimed to be unnecessary when using this process.

QUENCHING OIL....

. . . . A new series of quenching oils designed to produce better metal products more economically has been developed by the Sinclair Refining Co., 600 Fifth Ave., New York 20, New York. The oils offer greatly increased cooling power to assure a higher, more uniform degree of metal hardness, as well as greater depth of hardness. Indications are, according to Sinclair, that the new oil will produce substantial reduction of piece rejection rates and will enable metal working plants to use lower cost steels for critical purposes.

ELECTRODEPOSITING CHROMIUM....

. . . . A process for applying a chromium electroplate directly to aluminum has been granted U.S. Patent 2,662,054 and is assigned to United Chromium Inc., 100 E. 42nd St., New York 17, New York. As explained: the part is first given a coating of zinc and copper by immersion in an aqueous alkaline zinc—cuprocyanide solution and then dipped in nitric acid to remove the zinc-copper coating. A second dip is made, and the part is transferred to a chromic acid chromium plating bath, where the zinc-copper coating is dissolved and the part electroplated without removal from the bath. The result: chromium is deposited directly on the aluminum material.

TITANIUM DESCALING....

. . . . Heavy oxide scale has been successfully removed from hot rolled titanium by treatment in a sodium hydride bath operated at a temperature of 680-720 F. The Universal-Cyclops Steel Corp., 35 Stewart Street, Bridgeville, Pa., states that sheets ranging in thickness from 0.011 to 1.0 in. have been descaled by this method without burnout, provided the temperatures are controlled. A water rinse and two acid dips are used after descaling; the first an eight percent H_2SO_4 bath at 1,000 F; the second, which contains six percent HNO_3 and one percent HF, is operated at room temperature.

TESTS *PROVE*

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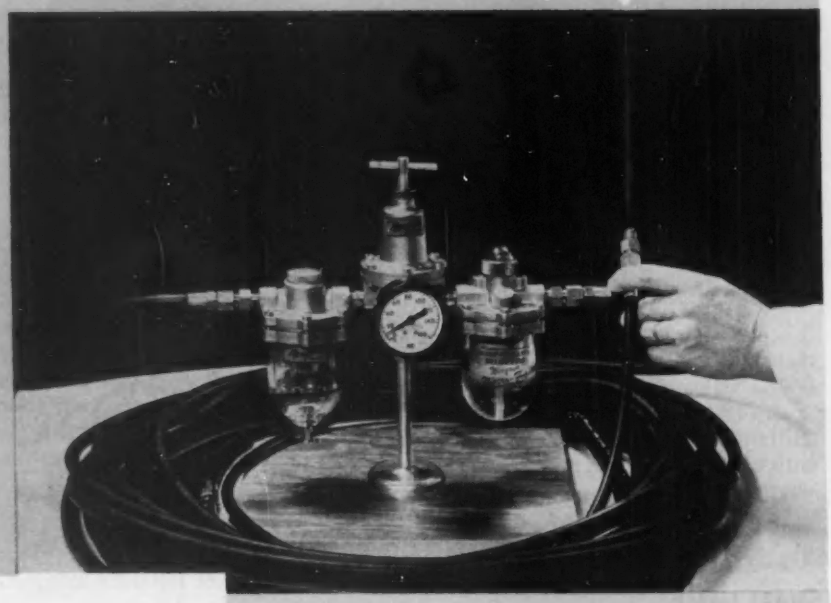

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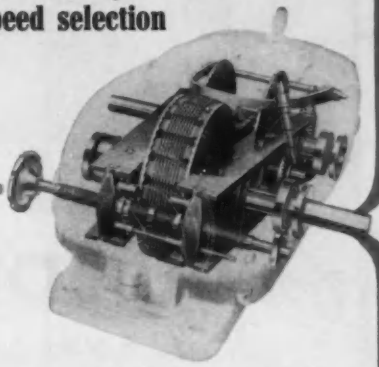
LINK-BELT's P.I.V. provides positive, infinitely variable speed selection

ALWAYS POSITIVE



ALWAYS STEPLESS

WHEREVER speeds must be varied—instantly, exactly, positively—you'll find Link-Belt's P.I.V. at work. Here's a variable speed drive that operates independent of friction. Exclusive self-tooth-forming chain meshes with grooved wheels, transmits power with no wasteful slip.

Without stopping the machine, you can select the speed you need—from maximum to minimum settings. And at any speed, full-rated horsepower is delivered.

If there's a process in your plant that requires precise speed selection, get all the facts about compact, all-metal P.I.V. Write for Catalog 2274, or call your nearest Link-Belt office or distributor. 12,451

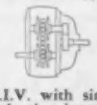
LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

LINK-BELT

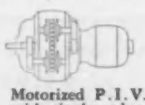
P.I.V. VARIABLE SPEED DRIVE

4 of 16 P.I.V. types, ½ to 25 hp — ratios to 6:1

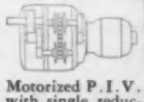
Basic P.I.V. Like all others, it is built for horizontal or vertical mounting.



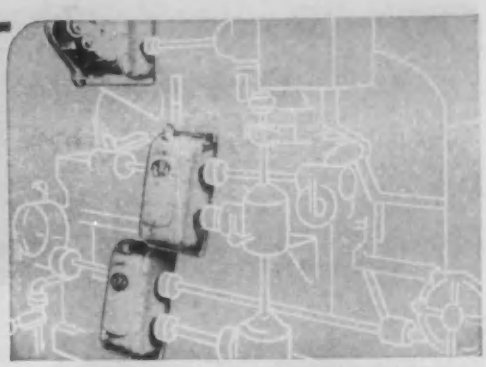
P.I.V. with single reduction input or output helical gears.



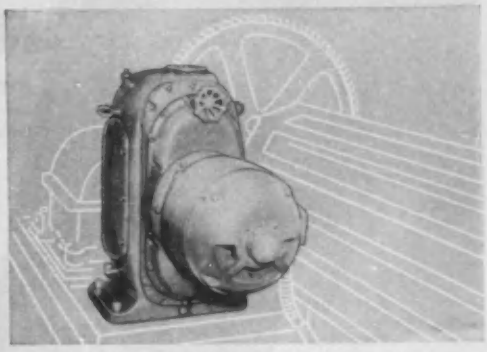
Motorized P.I.V. with single reduction input and output helical gears.



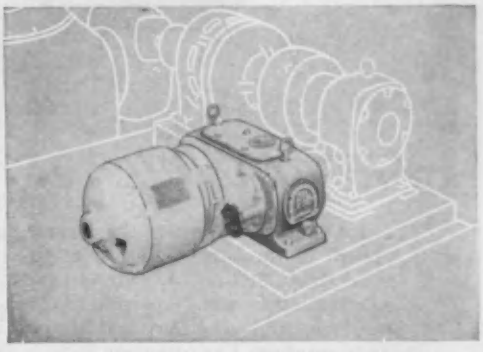
Motorized P.I.V. with single reduction input and double reduction output helical gears.



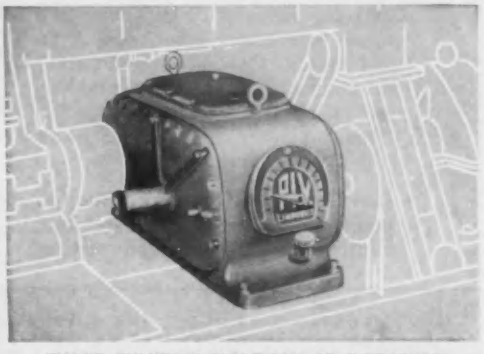
POSITIVE OPERATION OF DIFFERENTIAL SPEED EQUIPMENT. P.I.V. also provides precise regulation of rotary motion.



FLEXIBILITY IN TIMING. In addition, P.I.V. offers accurate control of processing speeds, unaffected by atmospheric conditions.



STEPLESS CONTROL OF PRODUCTION LINES OR INDIVIDUAL MACHINES, either manually or automatically, positively, dependably.



EXACT SYNCHRONIZATION OF ROTATING PARTS AND MACHINES. P.I.V. is needed where automatic sequence control must be stepless.

DIE CAST OF ZINC

for DUMORE

Here's Why.....

Since the above part is the largest single component of the pictured Dumore automatic drill head, the selection of material and process for its production was of paramount importance in achieving high efficiency and low cost of the finished product. The following factors dictated the choice of ZINC Die Casting:

Rapid Production—Because of the extreme complexity of shape and close tolerances attainable with ZINC Die Castings, an absolute minimum of secondary operations—burr removal, drilling, tapping, burnishing—are required to place this housing in service.

Low Cost Assembly—In addition to housing the entire motor assembly, compressor and return spring (see cutaway view), this hollow one-piece ZINC Die Casting has cored openings and cast projections to simplify assembly of all other operating components.

High Strength—A drill head comes in for a lot of abuse in its everyday usage and the inherent *toughness* of the ZINC Die Cast housing assures trouble-free performance of this machine tool under such conditions.

For many other instances of successful product engineering with ZINC Die Castings ask us—or any die casting company—for a copy of "The End Uses of Zinc Die Castings."

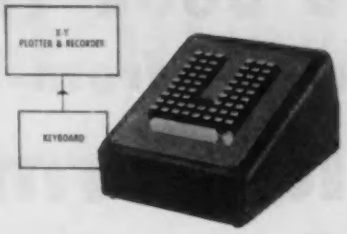
Send for your copy

The New Jersey Zinc Company
160 Front St., New York 38, N. Y.

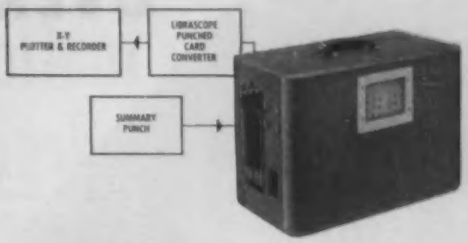
ZINC
FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on

HORSE HEAD SPECIAL (99.99+% Uniform Quality) ZINC



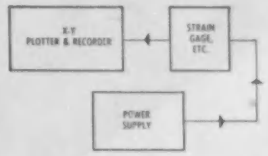
DECIMAL KEYBOARD: Consists of a three-decimal bank for each axis with associated plus-minus keys. Depressing plot bar initiates plot and clears keyboard automatically. Also manual clear button. Size: 8½ x 11 in., Weight: 12 Lbs.



PUNCHED CARD CONVERTER: Converts punched card data to an analog form suitable for input to X-Y Plotter from Gang Summary or Reproducing punches. Display Monitor. Total tube complement 25 tubes.

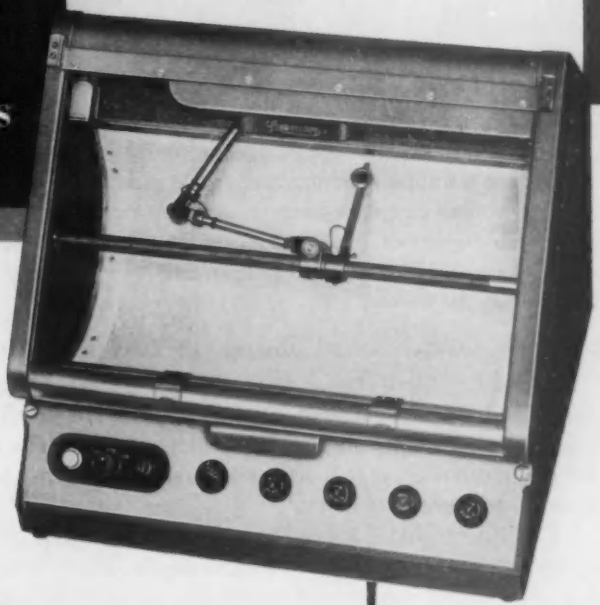
X-Y plotter and recorder

simplified recording of two independent variables with greater selection of input devices



D.C. INPUTS: 5 millivolt full scale sensitivity on both axes. Infinite input impedance for signals to .5 volts. 2 megohms input impedance above .5 volts.

A compact, desk-size unit that accepts either analog or digital inputs. Standard digital converters: Decimal keyboard, Decimal punched card, and Binary for Computer Outputs. Handles remote mechanical shaft rotations directly without modification. Modifications available to customer specifications. Full chart visibility allows observer to view curve generation at all times. Unique pen travel for fast, dependable performance. Write for full catalog information.



DESCRIPTION:
Desk or Rack Mounted
(RCA or RMA)
Accuracy: .1%
Weight: 70 lbs.
Uses Standard Graph Papers:
11" x 16½", or 8½" x 11"
Power Consumption:
150 watts, 115 volts, 60 cycles

Engineers, physicists and mathematicians in search of interesting assignments, rapid advancement, and job security are requested to write Dick Hastings, Personnel Director.

Computers & Controls

LIBRASCOPE

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

LIBRASCOPE, INCORPORATED 1607 FLOWER STREET, GLENDALE, CALIFORNIA

OVERHEAD DOOR TRACK
made from
Cold-Formed Shapes

This Cold-Formed Shape is a track section, used to guide the rollers of lift-type garage and warehouse doors. We make it on a rolling machine, using strip steel, and furnish it cut to length. The customer gives it further processing, and supplies it as a regular part of his door hardware. The sturdy shape is economical because it is light in weight, easy to install and gives years of trouble-free service.

Cold-Formed Shapes in Your Product

There's a good chance that you can use a Bethlehem Cold-Formed Shape to advantage in your product. The possible applications of these shapes are almost limitless—lately we've made them for use in ornamental railings, storage racks and industrial conveyor systems, to name only a few.

Bethlehem Cold-Formed Shapes come in any gage of strip, sheet or plate steel from 5 to 24. The most simple of pencil sketches submitted with your inquiry will enable our engineers to turn your idea into a practical and economical product.

A request to the nearest Bethlehem sales office will bring you our booklet on Cold-Formed Shapes. Or our representative will be glad to call on you and discuss your needs in detail.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

1736 Link-Belt helical gear drives chosen for Texas' newest pipe mill

Special, extra-thick cast steel housings withstand heavy shock loads at Lone Star Steel

Only the finest drive can deliver efficient, long-life operation under high temperatures . . . heavy, continuous loads . . . frequent, severe impact. That's why A. J. Boynton Co., designing and supervising engineers, approved the use of Link-Belt helical gear drives at Lone Star Steel.

And, because Link-Belt builds all drive components—speed reduction units, couplings, shafting, bearings and baseplates—the complete installation is *pre-integrated*. All dimensions are correlated—assuring accurate alignment and maximum performance.

Next time you've a demanding speed reduction problem, call in a Link-Belt power transmission engineer. Nowhere else will you find this unique combination of a broad line of pre-integrated, quality products . . . expert engineering . . . and undivided responsibility.

LINK-BELT

ENCLOSED GEAR DRIVES

In this Lone Star Steel Pipe Mill, Link-Belt helical gear drives are used on the Enterprise roller conveyor units, the Selas normalizing furnaces and the Sutton rotary straighteners. In addition, Link-Belt supplied chains, roller bearing steel pillow blocks, geared flexible couplings, fluid, worm, herringbone and P.I.V. variable speed drives for this important installation.

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.409-B

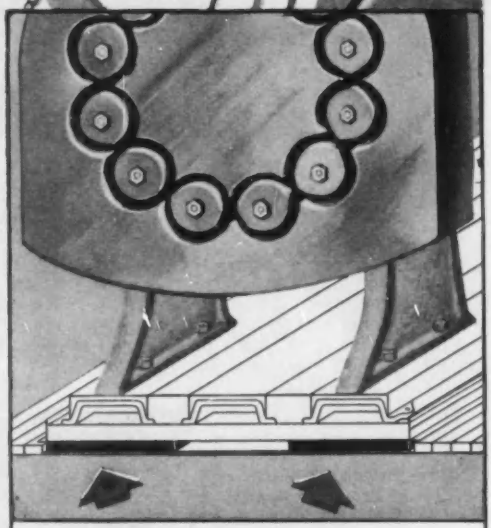
The office workers had the shakes...

but U.S. Sturdicell smoothed things out

When fourteen machines were installed in a four-story structural steel frame building in New Jersey, havoc broke loose. The machines caused so much noise and vibration that the office force on another floor found work unbearable.

Someone made a wise move and called in United States Rubber Company engineers. The "U.S." men proceeded to "float" the machines on U.S. Sturdicell rubber slabs, only one inch thick. The slabs were cut to the required width right on the job site with an ordinary knife. The result? Things not only quieted down in a hurry, but the machines now have extra protection against shock and impact loads, resulting in reduced maintenance costs.

Make a practice of consulting "U.S." on problems of this kind. We also manufacture a complete line of rubber-to-metal mountings. For complete information, call any of our 25 District Sales Offices, each staffed with engineers, or write address below.



Arrows indicate location of U.S. Sturdicell slabs that cushion machine.

"U.S." Research perfects it
"U.S." Production builds it
U.S. Industry depends on it

UNITED STATES RUBBER COMPANY
MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

IT'S NEW...IT'S NEWS!

...this 360° Bearing Counter

Smaller and more compact than ever, this new reset 360° Bearing Counter gives users several *bonus* advantages: It can be either base-mounted, or face-mounted flush with a panel surface. It will run at 1500 rpm constant speed or 2500 rpm on intermittent service . . . and it comes equipped with Geneva Transfer.

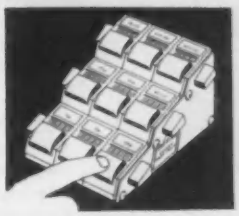
Added Evidence that —

Everyone Can Count on VEEDER-ROOT

This is another Veeder-Root "first" . . . the latest of one of hundreds of standard and special Veeder-Root Counters for every mechanical and electrical application. What do *you* want to count? Write:

ANOTHER NEW VEEDER-ROOT "FIRST"

New *Vary-Tally* Multiple-Unit Reset Counter gives you quick finger-tip count of anything countable. Comes in any combination up to 6 banks high, and 12 units wide (minimum of 2 units wide). Write for news sheet and prices.



VEEDER-ROOT INCORPORATED • HARTFORD 2, CONNECTICUT

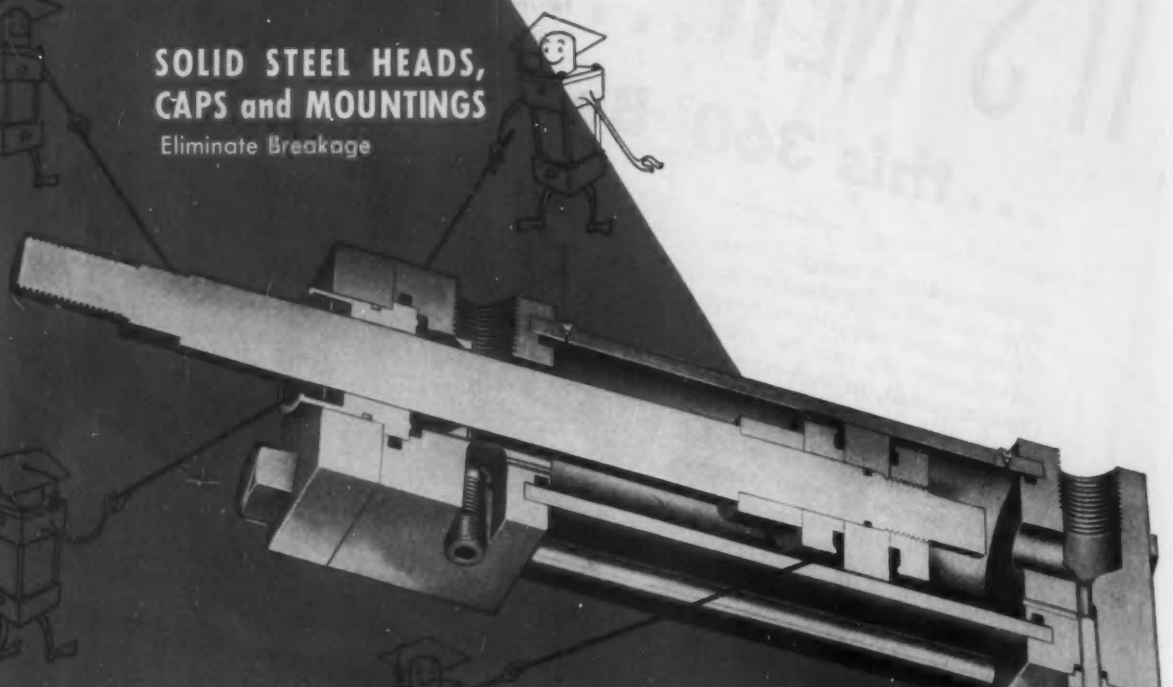
Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"The Name that Counts"

Miller HIGH PRESSURE HYDRAULIC CYLINDERS

HARD CHROME PLATED PISTON RODS
Prevent Scratch-Damage, Nicks and Rust

SOLID STEEL HEADS, CAPS and MOUNTINGS
Eliminate Breakage



DIRT WIPER SEALS
Protect Rods, Seals, Bushings

Standard Leather Cup Seal Assembly Shown Is Interchangeable With Miller Standard Piston Ring Piston Assembly

WRITE FOR CYLINDER BULLETINS H-104 and A-105

Complete Miller cylinder line includes: air cylinders, 1½" to 20" bores, 200 PSI operation; low pressure hydraulic cylinders, 1½" to 6" bores for 500 PSI operation, 8" to 14" bores for 250 PSI; high pressure hydraulic cylinders, 1½" to 12" bores, 2000-3000 PSI operation. All mounting styles available.

MET J. I. C. HYDRAULIC STANDARDS years before their adoption in 1949.

SPACE-SAVING SQUARE DESIGN originated by Miller in 1945.

SALES AND SERVICE FROM COAST TO COAST

CLEVELAND • YOUNGSTOWN • DAYTON • PITTSBURGH • PHILADELPHIA • BOSTON • HARTFORD • NEW YORK CITY • BUFFALO • ST. PAUL • GRAND RAPIDS • DETROIT • FLINT • FORT WAYNE • SOUTH BEND • INDIANAPOLIS • MILWAUKEE • LOUISVILLE • KANSAS CITY • SEATTLE • LOS ANGELES • SAN FRANCISCO • BALTIMORE • DENVER • ST. LOUIS • MOLINE • CHICAGO • HOUSTON • TORONTO, CANADA and OTHER AREAS

MILLER FLUID POWER CO.
(Formerly MILLER MOTOR COMPANY*)*

Miller **2002-04 N. Hawthorne Ave., Melrose Park, Illinois**

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

Augmenting Miller's Quality-Famous Line of "Custom-Built" Cylinders...

Miller Stock AIR AND HYDRAULIC CYLINDERS

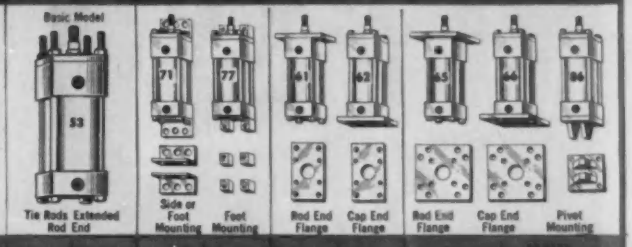
Available for *Immediate Delivery*...

in the popular sizes, mountings and prices listed below

Any of the interchangeable "stock" mountings illustrated can be easily attached to Basic Model 53 with the tie rod nuts in a few moments. This gives you a wide selection of models for **immediate use**—and permits easy conversion to other models for **future re-use.** You save delivery and production time, investment cost and storage space.

ORDER DIRECTLY FROM THIS LIST...

"Stock" Cylinders are shipped as Basic Model 53. Your selection of Mounting Attachments are shipped (unattached) with cylinders. Prices are F.O.B. our plant.



			BASIC CYLINDER PRICES ONLY		PRICES OF MOUNTING ATTACHMENTS ONLY					
Bore	Stroke	Cushion	AIR A53	HYD. H53	AIR A77 A71	HYD. H77 H71	AIR A61 A62	HYD. H61 H62	AIR A56	HYD. H65 H66 H84
1½"	2"	Non		$58.50		$2.90		$8.20		$14.35
1½"	4"	Non		60.70		2.90		8.20		14.35
1½"	6"	Non		62.90		2.90		8.20		14.35
1½"	8"	Non		65.10		2.90		8.20		14.35
1½"	11"	Non		68.40		2.90		8.20		14.35
2"	2"	Non	$37.70		$2.05		$4.60		$6.90	
2"	4"	Non	39.40		2.05		4.60		6.90	
2"	6"	Non	41.10		2.05		4.60		6.90	
2"	8"	Non	42.80		2.05		4.60		6.90	
2"	11"	Non	45.35		2.05		4.60		6.90	
2"	3"	Both	62.05	94.50	2.05	2.95	4.60	8.55	6.90	17.05
2"	5"	Both	63.75	97.00	2.05	2.95	4.60	8.55	6.90	17.05
2"	7"	Both	65.45	99.50	2.05	2.95	4.60	8.55	6.90	17.05
2"	9"	Both	67.15	102.00	2.05	2.95	4.60	8.55	6.90	17.05
2"	13"	Both	70.55	107.00	2.05	2.95	4.60	8.55	6.90	17.05
2½"	2"	Non	41.45	73.30	2.25	2.95	4.80	9.00	7.55	19.80
2½"	4"	Non	43.35	76.00	2.25	2.95	4.80	9.00	7.55	19.80
2½"	6"	Non	45.25	78.70	2.25	2.95	4.80	9.00	7.55	19.80
2½"	8"	Non	47.15	81.40	2.25	2.95	4.80	9.00	7.55	19.80
2½"	11"	Non	50.00	85.45	2.25	2.95	4.80	9.00	7.55	19.80
3¼"	3"	Both	77.80	126.85	2.55	4.35	6.35	11.75	9.90	23.10
3¼"	5"	Both	79.80	129.85	2.55	4.35	6.35	11.75	9.90	23.10
3¼"	7"	Both	81.80	132.85	2.55	4.35	6.35	11.75	9.90	23.10
3¼"	9"	Both	83.80	135.85	2.55	4.35	6.35	11.75	9.90	23.10
3¼"	13"	Both	87.80	141.85	2.55	4.35	6.35	11.75	9.90	23.10
4"	2"	Non	56.25	106.00	2.85	5.15	6.70	12.90	11.05	26.80
4"	4"	Non	58.85	109.40	2.85	5.15	6.70	12.90	11.05	26.80
4"	6"	Non	61.45	112.80	2.85	5.15	6.70	12.90	11.05	26.80
4"	8"	Non	64.05	116.20	2.85	5.15	6.70	12.90	11.05	26.80
4"	11"	Non	67.95	121.30	2.85	5.15	6.70	12.90	11.05	26.80
5"	3"	Both	98.25		3.15		7.00		12.35	
5"	5"	Both	101.65		3.15		7.00		12.35	
5"	7"	Both	105.05		3.15		7.00		12.35	
5"	9"	Both	108.45		3.15		7.00		12.35	
5"	13"	Both	115.25		3.15		7.00		12.35	
6"	2"	Non	80.60		3.35		7.25		13.55	
6"	4"	Non	84.90		3.35		7.25		13.55	
6"	6"	Non	89.20		3.35		7.25		13.55	
6"	8"	Non	93.50		3.35		7.25		13.55	
6"	11"	Non	99.95		3.35		7.25		13.55	
8"	3"	Both	157.35		3.70		10.55		17.60	
8"	5"	Both	162.45		3.70		10.55		17.60	
8"	7"	Both	167.55		3.70		10.55		17.60	
8"	9"	Both	172.65		3.70		10.55		17.60	
8"	13"	Both	182.85		3.70		10.55		17.60	

Miller "Stock" Cylinders fully meet the J.I.C. Standards and are identical to Miller "Custom-Built" Cylinders in design and construction.

"Stock" Air Cylinders are for 200 psi operation, "stock" hydraulic cylinders for 2000-3000 psi operation. Piston Rods of "Stock" Cylinders are "Style No. 2 Standard."

For complete descriptive and dimensional data on both "Stock" and "Custom-Built" Miller Cylinders, write for Bulletins A-105 and H-104 sent FREE on request.

Sales and Service From Coast to Coast!

Consult your local directory or write us direct for the name of our representative for your area

Complete Miller "custom-built" line includes: air cylinders, 1⅛" to 20" bores, 200 psi operation; low pressure hydraulic cylinders, 1⅛" to 6" bores for 500 psi operation, 8" to 14" bores for 250 psi operation; high pressure hydraulic cylinders, 1⅛" to 12" bores, 2000-3000 psi operation. All mounting styles available. Also, a complete line of Fluid Pressure Boosters and Accumulators.

MILLER FLUID POWER CO.

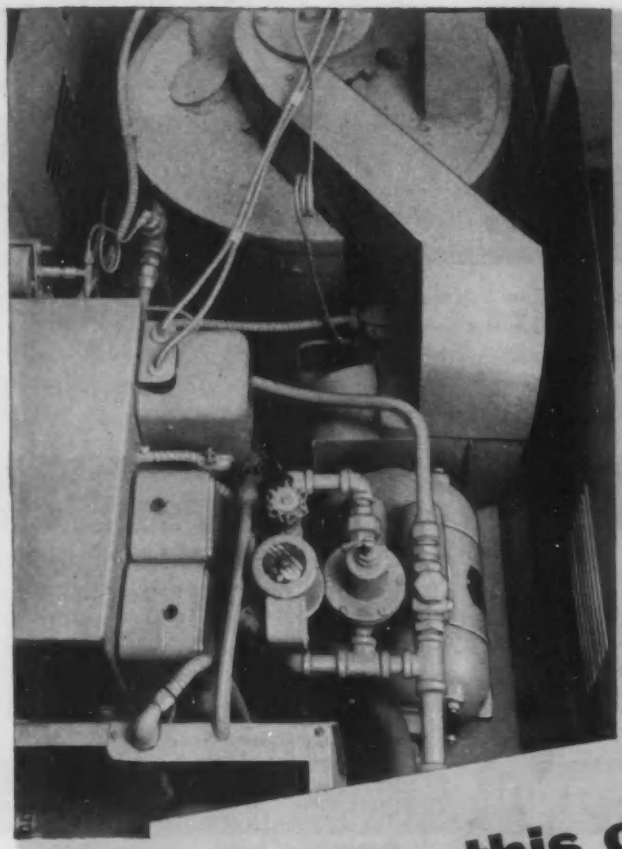
(Formerly MILLER MOTOR COMPANY*)*

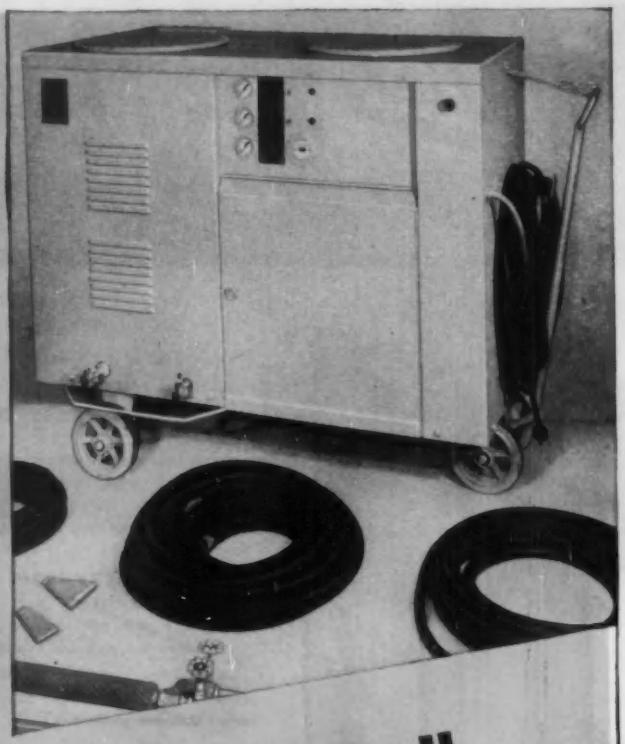
Miller

2002-04 N. Hawthorne Ave., Melrose Park, Illinois

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS

COUNTERBALANCE CYLINDERS





Inside this compact Aeroil Auto-Steam Cleaner

there's compact power by a HOOVER MOTOR

Flexible!

Aeroil saved much time and money in the development of this Model B3 vapor steam cleaner—thanks to Hoover flexibility. Sample motors for design changes and testing needs could be made almost immediately—Hoover delivered in an average cycle of four days.

Economical!

The Hoover motor was engineered to the Aeroil job—with many special mechanical details—for low-cost operation, full-rated horsepower and compact design. And, as Aeroil puts it, "Hoover also contributed immeasurably to styling, efficiency and easy maintenance of the Auto-Steam Cleaner."

Unique!

Together, Aeroil and Hoover developed an entirely new and unique motor installation—one which would meet rigid military specifications and yet adapt to domestic market requirements. Now this famous Hoover-powered Auto-Steam Cleaner is proving its worth around the world.

Send this coupon now if you make, or plan to make, any equipment calling for a fractional or integral horsepower motor, up to 5 h.p. The Hoover catalog lists dozens of low-cost, in-production models in stock or available on short notice. Or we can set up a meeting with Hoover engineers who will work with your engineers to tailor-make your motor to your most exacting mechanical and electrical details. No obligation, of course.

PRODUCTION FOR HOME AND DEFENSE
Week in and week out, Hoover is producing a very substantial volume of essential materials for the Armed Forces.

THE HOOVER COMPANY, ELECTRIC MOTOR DIVISION
90 BROOK AVENUE, NORTH PLAINFIELD, N. J.

Please send me further information on Hoover Motors. I am particularly interested in motors for

_____
(Indicate type of equipment)

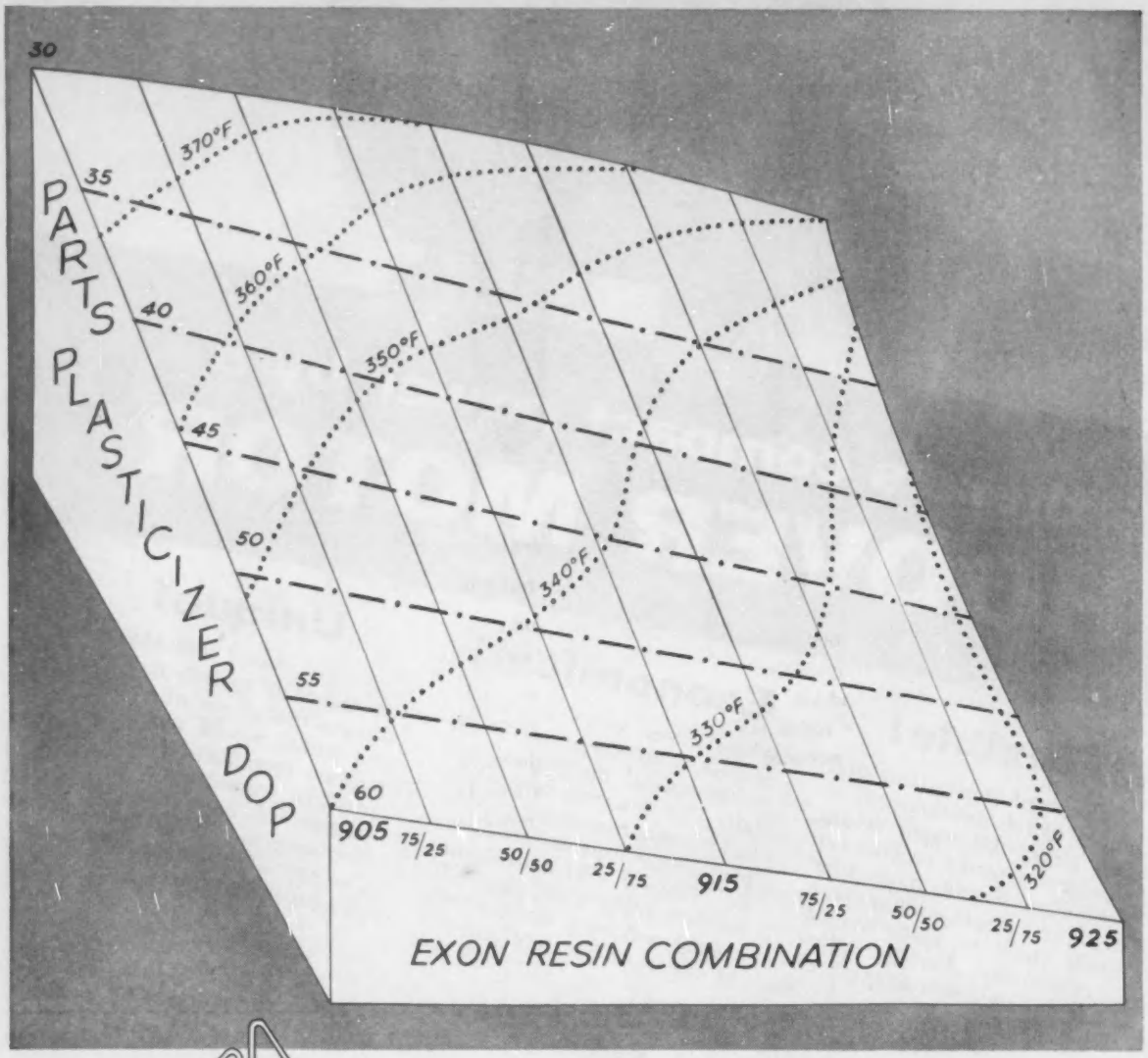
Name_____

Company_____

Address_____

City_____ Zone_____ State_____

now Firestone helps you
CHART YOUR PROCESSING



Firestone Service charts your processing needs in

3 DIMENSIONS!

Consult this unique chart to determine the proper combination of Exon resins best suited to your processing conditions.

Follow the broken guide lines indicating Parts Plasticizer to the intersection of your Operating Temperature, indicated by dotted lines. Carry this point parallel to the solid black lines down to the Exon Resin Combination at the bottom of the graph.

PROBLEM...AND SOLVE IT!

with Firestone's 3 new versatile, temperature-tailored resins

EXON 905 – 915 – 925

Operating temperature is virtually eliminated as a production problem by Firestone's 3 new EXON resins—905–915–925.

You need only determine your plasticizer loading and your operating temperature. Spot them on the chart at left—and you find the temperature-tailored resin or blend ideally suited to perform in your processing with excellent results.

These fast-fusing Exon resins offer you several inherent advantages. Among them are:

- Extremely rapid blending . . . hot or cold.
- Freedom from fisheyes . . . for higher quality, greater product uniformity.
- Shorter fusing time . . . assuring a faster, more economical operation.

For final adjustments to given processing conditions, a blend of one or more of the Exon resins may be used.

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SPE THE SIXTH national plastics exposition CLEVELAND JUNE 7-10 1954

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BASIC MATERIALS EXPOSITION

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PHYSICAL PROPERTIES

	FORM	SPECIFIC GRAVITY	AVERAGE RELATIVE VISCOSITY	AVERAGE BULKING DENSITY
EXON 905 Excellent for film and sheeting applications where higher temperatures (up to 375° F.) are called for.	White Powder	1.40	2.50	0.45
EXON 915 High-versatility, resin specially designed for sheeting. Wide range of operating temperatures.	White Powder	1.40	2.30	0.45
EXON 925 An excellent P. V. C. resin for low processing temperatures. (starting at 275° F.)	White Powder	1.40	2.05	0.45

For further information on Firestone's complete line of high quality EXON resins . . . or for the assistance of Firestone's Technical Service, call or write:

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Division of The Firestone Tire & Rubber Co.

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"TIMING" BELT DRIVE ENGINEERING HANDBOOK

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Introduced on a limited scale only eight years ago, the Gilmer "Timing" Belt Drive is now so widely accepted the list of its users reads like a "Who's Who" of machinery manufacturers. Well over a million of these super-efficient, non-slip belt drives are used daily to transmit loads from 1/100 to 300 HP as well as to maintain precise synchronization between two or more shafts.

Now, even more firmly establishing the "Timing" Belt as a new and proved power transmitting medium, we are proud to announce the production by McGraw-Hill of an authoritative engineering handbook containing all facts and formulas involved in calculating and designing both belts and pulleys for all types of "Timing" Belt Drives.

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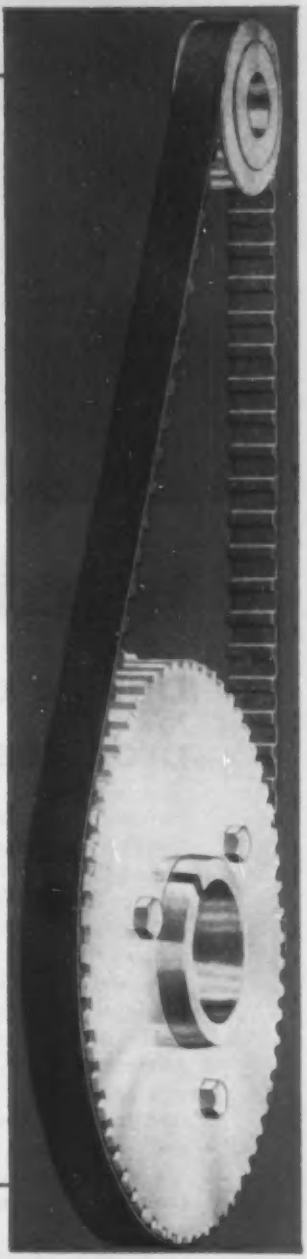
If you design power-driven machinery of any kind, a copy of this handbook should be at your finger tips. Use the handy order form below. You need send no money with your order. We'll gladly bill you—or your firm—on 30-day terms if you so indicate.



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Please forward.....copies of the "Timing" Belt Drive Engineering Handbook at $3.50 per copy, postpaid.

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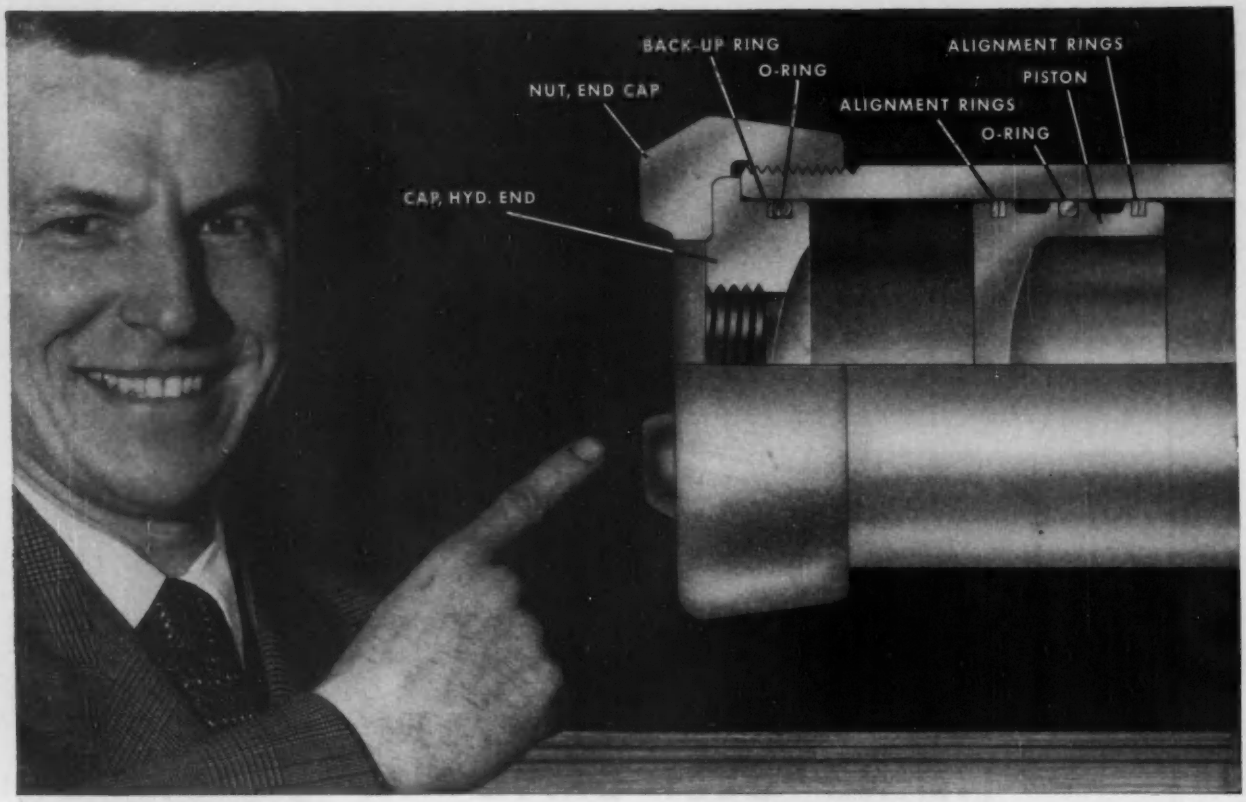


Introducing new Parker

Unique design avoids wear and maintenance, provides longer life than other types

Here at last is an industrial hydraulic accumulator that provides a longer life than conventional types.

As you see in the cutaway, construction is simple. The shell is corrosion-resistant alloy steel; the piston is aluminum. Wiper alignment rings support the piston. O-rings are used only to seal fluid and pressure. This unique design reduces frictional wear to a minimum.

The new Parker accumulator is designed for greater safety, too. During dismantling, a safety vent in the end cap warns of trapped gas pressure. It allows this pressure to escape before the end cap is removed completely.

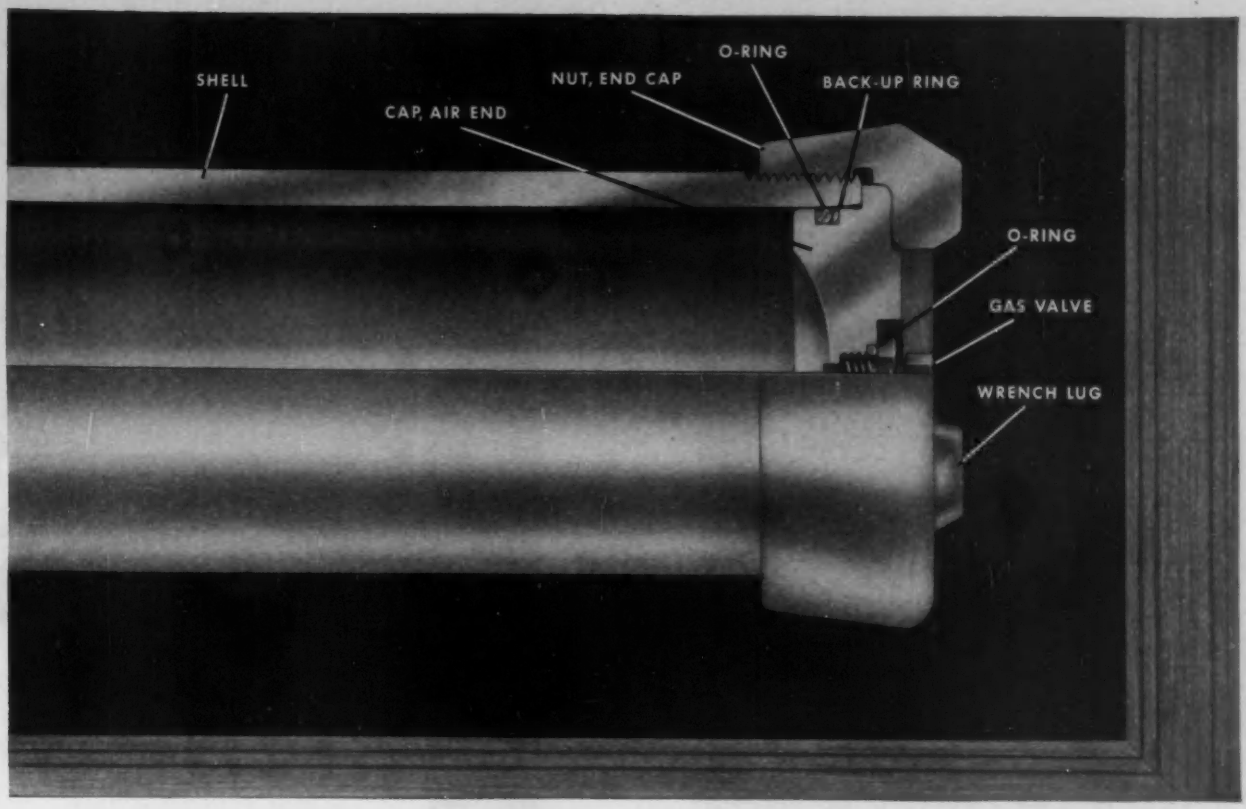
This new accumulator is offered in eleven sizes. Lengths vary from 9⅜ to 40 inches. Inside diameters are 1½, 4, or 7 inches. Oil volume capacities range from 10 to 1155 cubic inches. Maximum operating pressure rating is 3000 psi.

Also, for accessory use with accumulators, Parker offers a complete line of quick-opening, no-chatter check valves.

If you're not using accumulators, you'll find they can greatly simplify hydraulic system design, providing a means of steady power and saving wear on pumps. For information, mail the coupon.

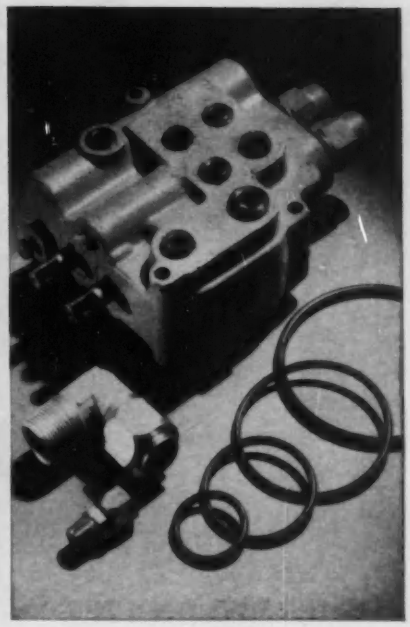
INDUSTRIAL HYDRAULICS DIVISION
The Parker Appliance Company
17325 Euclid Avenue, Cleveland 12, Ohio

Parker
Hydraulic and fluid system components



piston-type accumulator

100% safety tested on stands like this, all Parker industrial accumulators are checked at hydraulic pressures up to as high as 10,000 psi.



What other Parker products for hydraulic and fluid systems interest you? Triple-lok flare fittings? Ferulok flareless fittings? Synthetic rubber O-rings? Any other products?

THE PARKER
APPLIANCE COMPANY
Section 202-L
17325 Euclid Avenue
Cleveland 12, Ohio

Please send the following:

☐ Accumulator Catalog File 1536A

☐ Catalogs describing these other Parker products_____

NAME_____

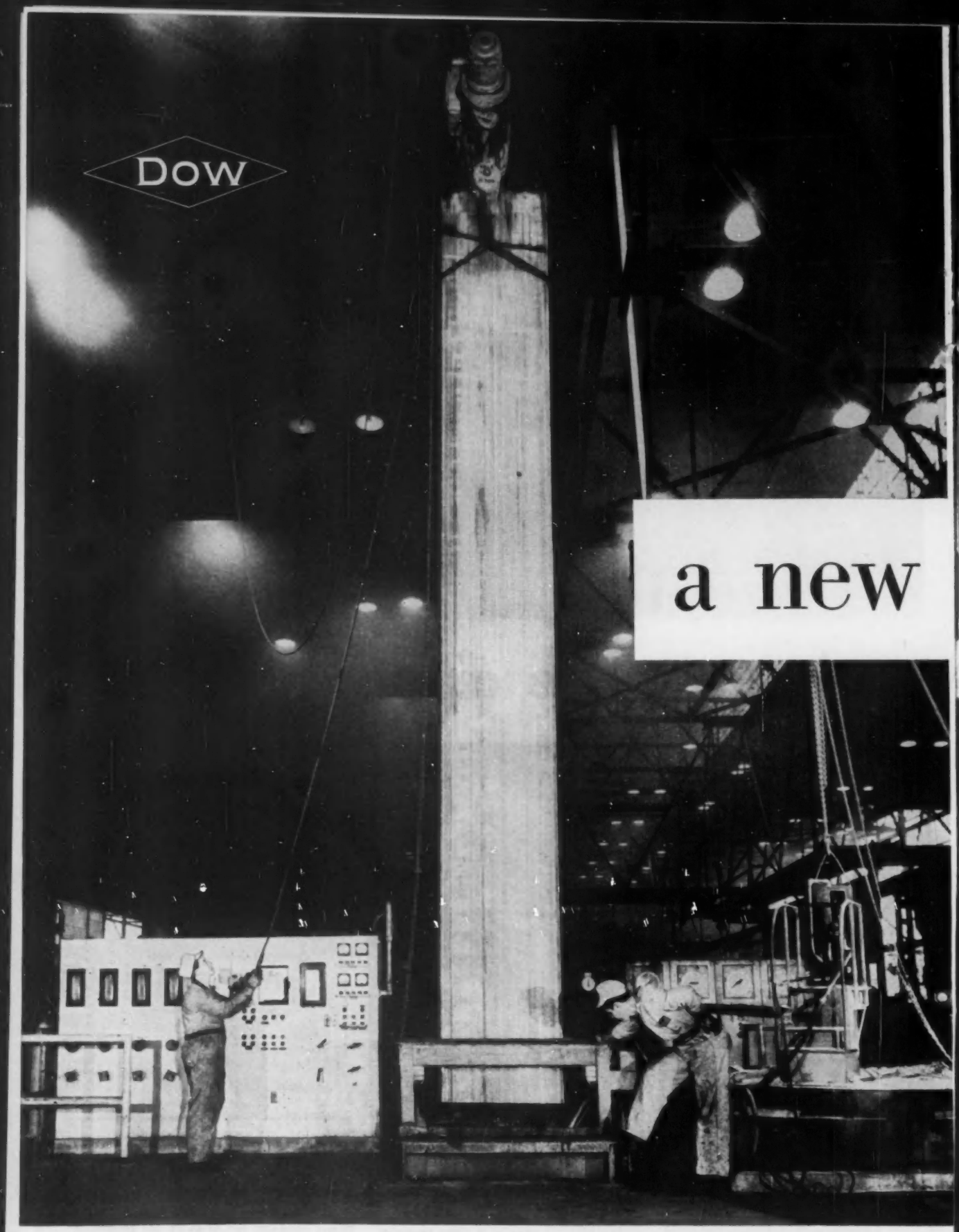
TITLE_____

COMPANY_____

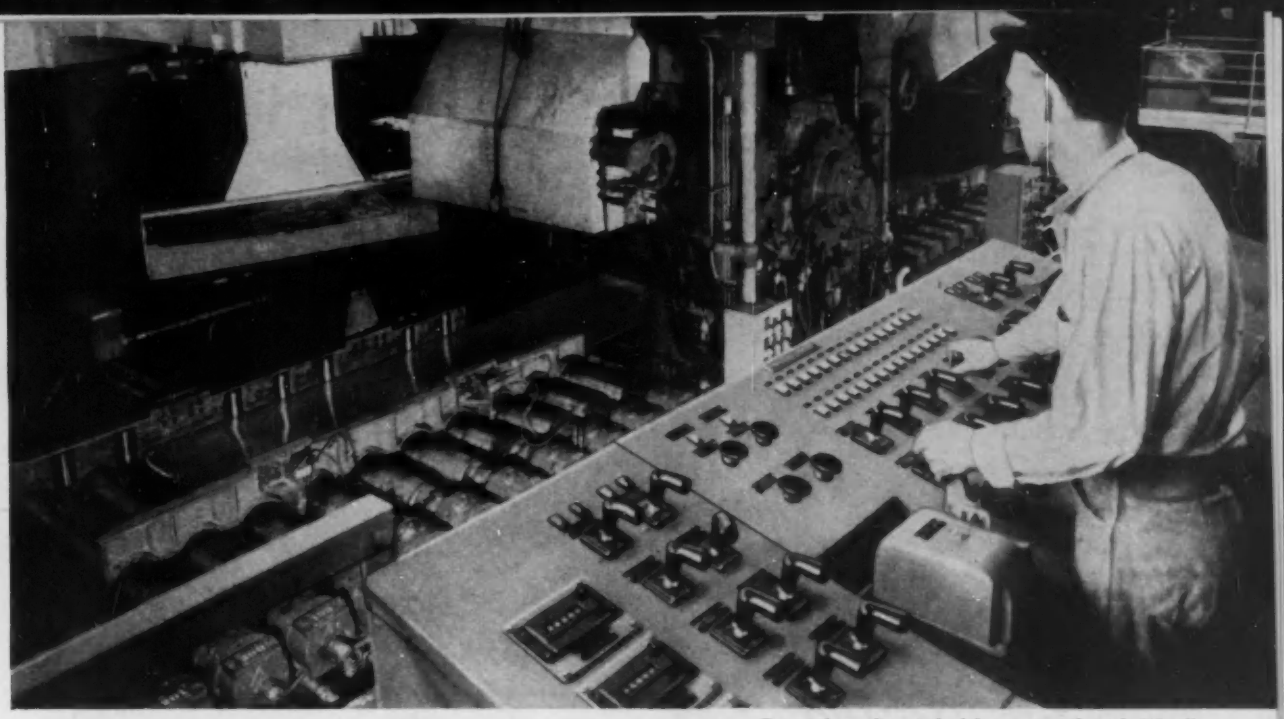
ADDRESS_____

CITY_____ STATE_____

Mail this coupon for technical information about Parker's trouble-free accumulator. If you'd like to know more about other Parker products, list them on the coupon.



FIVE TONS OF "LIGHT WEIGHT"! Known everywhere as the "world's lightest structural metal," it's something new indeed to see magnesium rolling ingot in five-ton lengths being lowered away to huge saws in rooms beneath the earth—where shorter ingots can be prepared for rolling in Dow's new coil mill.

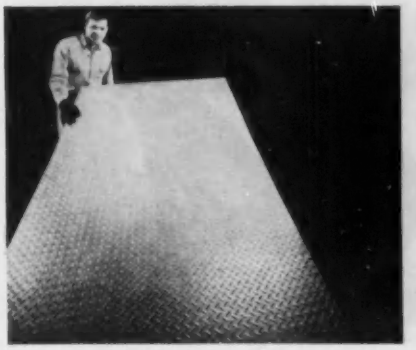


Operator's touch controls slab movement through 84" rolls.

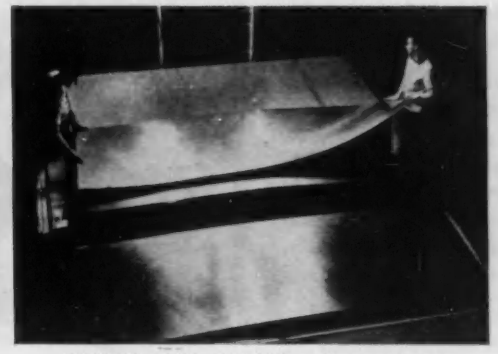
look at Magnesium!

UP TO 25% PRICE REDUCTION ON PLATE & SHEET

Now Available! Tremendous new Dow facilities, now in operation, are geared to supply large quantities of magnesium plate, sheet and extrusions—in many new sizes, shapes and forms. Years of experience with magnesium were combined with newest *volume production techniques* to create the world's first 84-inch coil mill for rolling magnesium. If you are a designer, engineer or manufacturer —anxious to cut costs and improve products—it's time to take a *new look* at strong, lightweight magnesium! Call the nearest Dow office or write today for information—THE DOW CHEMICAL COMPANY, Magnesium Sales Department, Midland, Michigan.



MAGNESIUM PLATE—Light, strong magnesium tread plate—lengths to 16 feet, widths to 6 feet, thickness to 2 inches.



MAGNESIUM SHEET — New production facilities and rigid inspection insure top quality magnesium products.

MAGNESIUM COIL—Note size of coil, illustrates new availability in greater widths and lengths.

you can depend on DOW MAGNESIUM

DOW

Standard KLIXON Thermo Snap CONTROLS

will meet your requirements . . . usually at lower cost!

Because Klixon Snap-Acting Temperature Controls are simple and foolproof with *no* complicated operating mechanism, they *always* provide accurate control in every application.

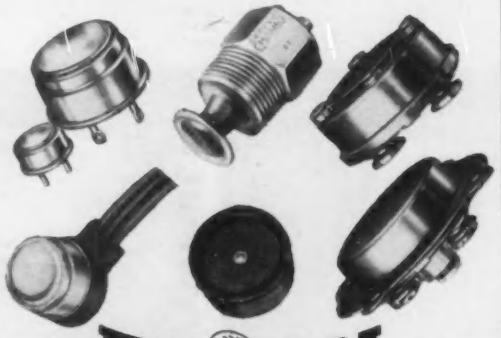
Small, light-weight, compact, they fit into products without complicated design alterations. They operate surely and dependably even under shock, vibration motion or altitude no matter what positions they are mounted. And because you can usually find a standard Klixon Thermo-Snap Control to do the job properly, you save money by eliminating new thermostat design and manufacturing costs.

What's your temperature control problem . . . low and high limit controls, fuel delay switches, tube and rectifier cooling, fan switches, temperature control . . . Klixon Thermo-Snap Controls are meeting the requirements for these and other applications in military and civilian products, daily.

Klixon Thermo-Snap Controls are available in many hermetically sealed and open types in a wide variety of operating temperature ranges.

Klixon Engineers, specialists in temperature control applications, can help you solve your specific problems. Write for their help or further information.

TYPICAL KLIXON THERMO-SNAP CONTROLS



KLIXON

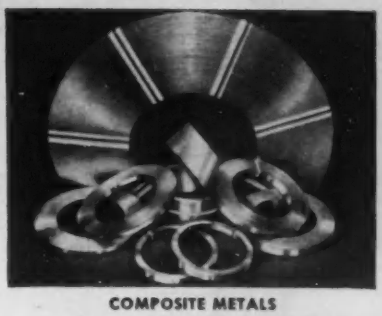
METALS & CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
905 FOREST ST., ATTLEBORO, MASS.

General Plate Products

that solve your Design Problems

TRUFLEX THERMOSTAT METALS

TRUFLEX thermostat metals are manufactured in a wide variety of types, each with a different reaction to temperature. Uniformity of metal insures accurate and consistent performance. Precision parts fabricated to exact specifications.

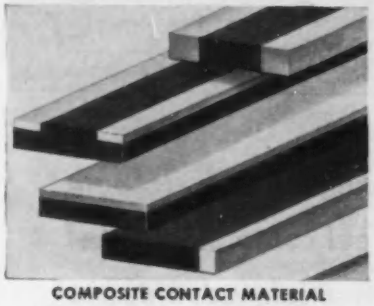


COMPOSITE METALS

Available in practically any combination of precious to precious, precious to base or base to base metals. Combinations for electronics include aluminum-clad iron, nickel-clad iron for anode materials.

ALCUPLATE

Copper-clad aluminum for component cases or cans, chassis, cooling fins, etc., light weight, excellent conductivity. Copper surface is ideal for soft soldering and electroplating.



COMPOSITE CONTACT MATERIAL

Precious metals and alloys bonded to base metals available in following types — overlay, single and double edgelay, single and double inlay, Top-Lay, ready for you to fabricate into contacts.

COMPOSITE CONTACTS

General Plate can supply all types of fabricated composite contacts, buttons, rivets, contact assemblies made to customer's specifications. These contacts give electrical conductivity and long life at reduced costs.

WAVE GUIDE and COLLECTOR RINGS

RECTANGULAR WAVE GUIDES. Solid silver, silver lined brass or aluminum. Sizes to government specifications.
COLLECTOR RINGS. Solid silver or precious metal on base metal. All sizes.

GENERAL PLATE PRODUCTS

- **Alfer, Alnifer, Nifer** — Aluminum and Nickel-clad steel for anode plates.
- **Alcuplate®** — Copper-clad aluminum for component cases, chassis, cooling fins, condenser blades, etc.
- **Alsiplate®** — Silver-clad aluminum for lightweight condensers, etc.
- **Composite Contacts and Contact Materials**—Increased strength and longer life at reduced cost.
- **Collector Rings** — Fabricated from solid precious metals or precious-clad base metals. Sizes ranging from fraction of an inch to few feet in diameter.
- **Truflex® Thermostat Metal** — Sheet, strip, formed elements and assemblies produced to specification.
- **Thin Gauge Metals** — Beryllium copper, nickel, pure beryllium, Haynes Stellite alloys, etc.
- **Platinum-Group Metals** — Sheet, wire, tubing, parts of all types. Complete assay and refining facilities for platinum-group metals.
- **Silver and Gold Brazing Alloys** — Available as sheet, wire, powder and fabricated parts.
- **Bondwich** — Solder-clad brazing shim for carbide-tipped tools.
- **Bronco** — Phosphor Bronze-clad copper for high conductive springs.
- **Conflex** — Copper-clad spring steel for electrical and thermal conducive springs at low cost.
- **#720 Manganese Age-Hardening Alloy** — Corrosion resistant spring material for diaphragms, springs, finger stock, etc.
- **Rectangular Wave Guide Tubing** — Wide range of sizes to government specifications.

Write for catalog PR700

General Plate Composite Metals, made by metallurgically bonding one metal to another, are available in sheet, strip, tubing or wire in various widths, thicknesses and diameters.

Silver, gold and platinum-group metals bonded on base metals give solid precious metal performance at a fraction of the cost of solid precious metal. The precious metal provides specific performance requirements such as electrical conductivity and corrosion resistance while the base metal provides workability, strength, and solderability.

Composite base metals provide a new group of engineering metals with properties not available in solid metals. Their use frequently results in lower material costs as compared to solid metals.

In many applications further economy results when General Plate supplies fabricated parts ready for assembly into your product. General Plate makes an infinite variety of fabricated parts, such as electrical contacts, collector rings and TRUFLEX thermostat metal parts to customer's exact specifications.

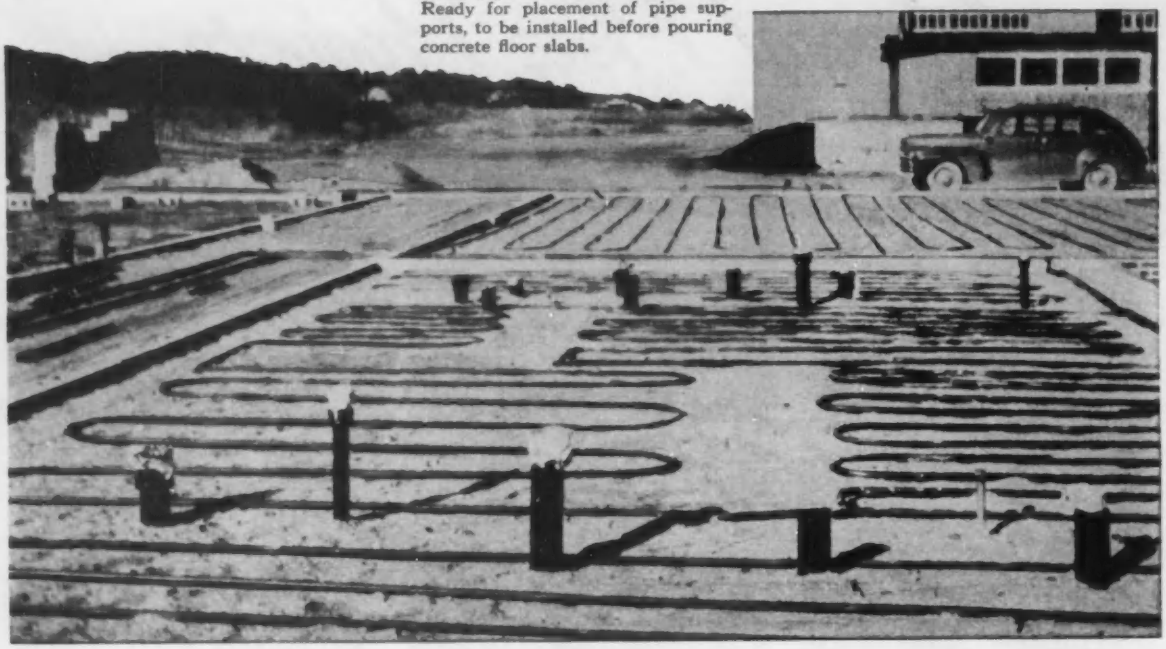
General Plate Engineers will gladly help you with your problems.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
15 FOREST STREET, ATTLEBORO, MASSACHUSETTS

Where It Can Save You Money

Yoloy pipe used for radiant heating. Ready for placement of pipe supports, to be installed before pouring concrete floor slabs.



long life underground too

. . . Piping of high strength low alloy steel containing nickel provides multiple advantages

INDUSTRY has widely adopted concealed piping for such diverse applications as radiant heating indoors and removal of snow from city streets.

Regardless of its purpose, however, where buried or concealed piping is involved *only long-lasting pipe can be economical.*

You can see such piping, above, made from the same composition of nickel alloyed steel which has proven so successful in the oil, mining, railroad, chemical, trucking and other industries.

Weldable, and of high mechanical strength, it is produced by The Youngstown Sheet and Tube Company, Youngstown, Ohio, under the tradename Yoloy Continuous Weld Pipe.

In standard tests, Yoloy shows four to six times greater resistance to atmospheric corrosion than does carbon steel. Furthermore, Yoloy piping resists attack from highly sulphurous atmosphere, brine and many other corrosives.

In addition, it resists abrasion and shock to an extent unmatched by any carbon steel of equal strength.

Another valuable advantage . . .Yoloy pipe can be electric or gas welded, readily. And the welds show approximately the same strength and ductility as the parent metal.

Easy to thread and fabricate with standard pipe tools, Yoloy Continuous Weld Pipe is one more example of the improved performance and ready response to fabrication derived from steels containing nickel.

In all sorts of applications, nickel alloyed steels prove to be lowest in ultimate cost. For actually, the many standard grades available make it easy to select exactly the right one to meet any reasonable combination of fabricating and service demands.

Whatever your industry, send us details of your metal problems. We'll be glad to help you with suggestions based on wide practical experience.

EMBLEM OF INCO SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.

FACTORY-EQUIPPED WITH

A line-up of punch presses on the shipping floor of Julius Blum & Co., Carlstadt, N. J., all factory-equipped with A-B controls.

Machinery builders find the new 6th Edition, 120-page Handy Catalog a helpful guide in selecting motor controls for any machine. Let us send you a copy.

Allen-Bradley Co.
1316 S. Second St., Milwaukee 4, Wisconsin

A-B Quality

THE ALLEN-BRADLEY *Trademark*—

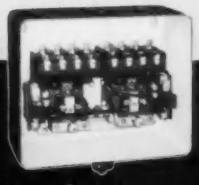
is a Guarantee of Trouble-free Motor Control and a Plus Value in Machine Tool Sales

If you make motor-driven machines . . . which are sold "factory-equipped" with motors and controls . . . you assume over-all responsibility for, and can guarantee, the satisfactory operation of the whole machine. This fact can be converted into a powerful sales asset. By featuring Allen-Bradley controls on your machines, you provide assurance that the controls are of the best. Allen-Bradley starters, relays, and contactors have an established reputation for long, trouble-free life . . . they are good for millions of switching operations.

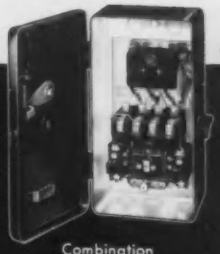
Allen-Bradley Size 1 Motor Controls—Rated 5 hp, 220 v; 7½ hp, 440-550 v.

Manual Starter

Automatic Starter


Reversing Starter

Multispeed Starter


Combination Starter

5-54-R

A-B Quality

ALLEN-BRADLEY

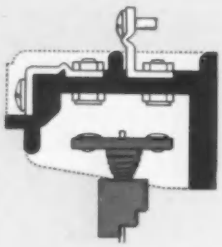
SOLENOID MOTOR CONTROLS

QUALITY

Bulletin 709 Starters are SO TROUBLE FREE

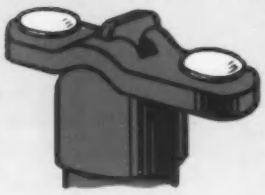
••• ••• *because they are* SO SIMPLE

DOUBLE BREAK, SILVER ALLOY CONTACTS—NO MAINTENANCE

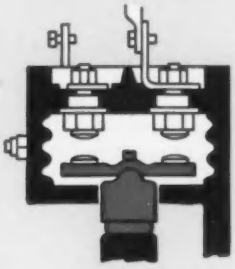


SIZES 0 & 1

Some 20 years ago, when Allen-Bradley announced the new Bulletin 709 solenoid starter, a big feature was the change from single break, copper-to-copper contacts to double break, silver alloy contacts. A warning on the name plate said: DO NOT FILE, CLEAN, OR DRESS CONTACTS.

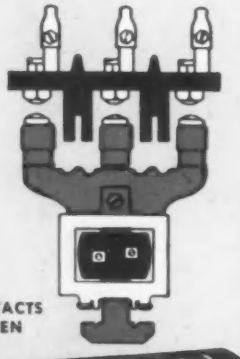


At first, maintenance electricians paid little attention to this request. Who had ever heard of running motor starters without contact maintenance? But, today, the dependability of Allen-Bradley starters is taken for granted. They have proved they are good for millions of trouble-free switching operations.



SIZES 2 TO 7

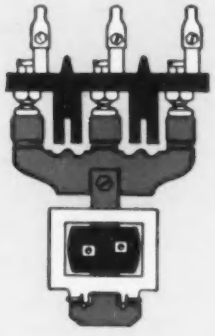
ONLY ONE MOVING PART—NOTHING TO RUST AND STICK



CONTACTS OPEN

The Allen-Bradley solenoid starter design was new and revolutionary in 1934. By doing away with clapper contactors, it eliminated hinged linkages, pivots, pins, and bearings. Only one moving part . . . the one-piece solenoid plunger . . . opens and closes the contacts with a simple up-and-down motion. Such simplicity assures unfailing operation.

Today, millions of Allen-Bradley solenoid relays, contactors, and switches are in active use. They have set a standard of performance which has expanded the use of automatic controls. Allen-Bradley solenoid controls sustain almost unbelievable production records. Look for the A-B trademark. It means QUALITY in motor control.



CONTACTS CLOSED

Under the same operating conditions a machine with many moving parts is more likely to develop trouble than a simpler machine with fewer moving parts.

The same rule holds true for motor starters. Most starters have complicated linkages, bearings, hinges, pins, and pivots in their mechanisms. Each moving part is a potential troublemaker.

Allen-Bradley Bulletin 709 magnetic starters are SIMPLE—they have ONLY ONE MOVING PART. If you want maintenance free motor controls . . . specify Allen-Bradley. Let us send you the latest A-B information—the A-B Handy Catalog.

Allen-Bradley Co.
1316 S. Second St., Milwaukee 4, Wis.

Bulletin 709 starters: Sizes 0 to 4. Sizes 5 to 7 not shown.
Max Rating: 300 hp, 220v; 600 hp, 440-550v.

ALLEN-BRADLEY

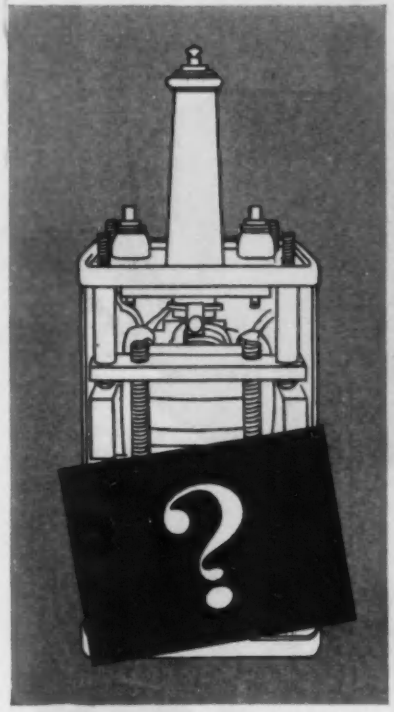
TROUBLE-FREE MOTOR CONTROLS

QUALITY

A-B Quality

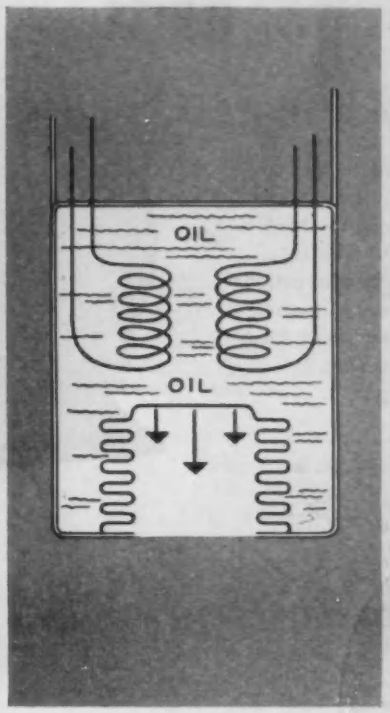
5-54-R

IDEAS that started in a BELLOWS



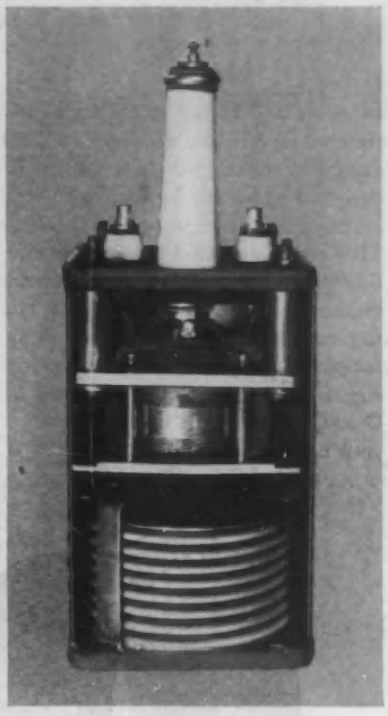
PROBLEM: EXPANSION IN HERMETICALLY SEALED UNITS

When current flows through a transformer, heat makes the oil expand which would distort the unit. When the temperature again drops, contraction could leave a void in the chamber, which is also undesirable. This led to inquiry about bellows.



NOW "STANDARD PROCEDURE"

When the oil in this hermetically sealed transformer as made by Sperry Gyroscope Company expands, a metal bellows automatically contracts, giving it room. As the oil contracts, the bellows expands, filling the void.



AND HERE'S THE ANSWER

The Clifford metallic bellows used is flexible and leakproof, assures absolute maintenance of the hermetic seal because the pressure is on the bellows — not the seal. Such a transformer can be mounted in any position . . . performs better under vibration.

Have you ever worked with Bellows?

Some of the oldest problems in engineering — and some of the newest — are today being solved through use of bellows, as knowledge of their versatility and simplicity becomes wider spread.

Clifford metallic bellows are serving in a great variety of temperature and pressure control systems. They are simple to install, prove to be accurate and dependable and perform under a wide range of climatic and temperature conditions.

They are used for these purposes in diesel engines, stationary and automotive types as well as passenger cars and trucks . . . water heating or cooling systems . . . electric appliances . . . electronic devices . . . steam coolers . . . acid baths and much other equipment.

To know more about bellows and their uses, please fill out and mail the coupon.

CLIFFORD MANUFACTURING COMPANY, Waltham 54, Massachusetts. *Division of Standard-Thomson Corporation.* Sales offices in New York; Detroit; Chicago; Los Angeles; Waltham, Massachusetts.

CLIFFORD MANUFACTURING COMPANY
122 Grove Street, Waltham 54, Massachusetts
Gentlemen:
Please send me information on bellows application for temperature control. Also for
☐ Vacuum tube adjustments ☐ Transmitting motion between two mediums ☐ Sealing rotary shafts or packless valves ☐ Transmitting motion hydraulically to remote points ☐ Providing for thermal expansion ☐ Providing shock mounting or vibration dampening ☐ Differential pressure control

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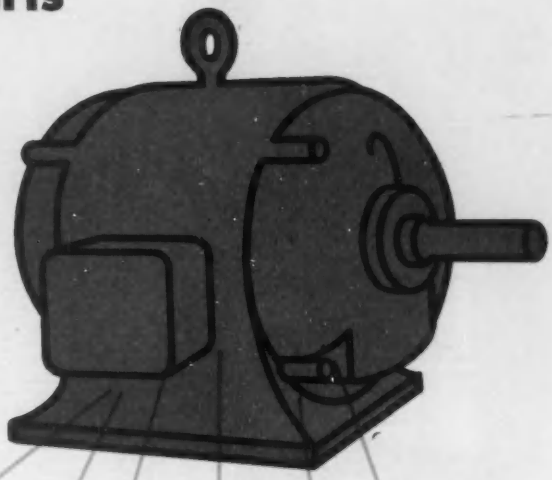
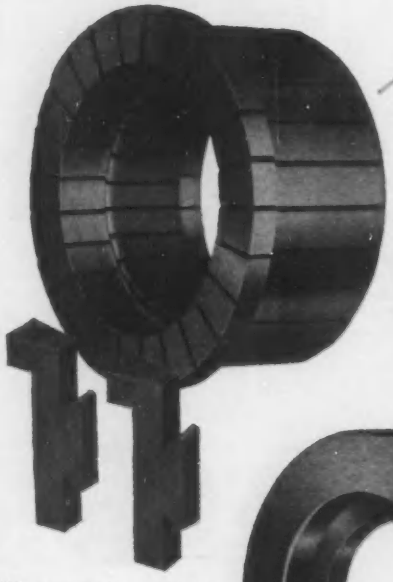
dependable electric motors use GRAMIX® parts

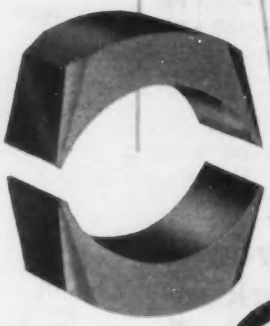
In many and varied motor applications, GRAMIX sintered metal parts are proving their strength and durability in rugged daily service because they are designed and made by men who really know motors . . . men who have years of experience in the field. This is a plus factor for you because in addition, GRAMIX parts cost less than those made by conventional methods, cut manufacturing time, eliminate machining, and can be delivered faster! Why not write today for our big new GRAMIX catalog or the specific engineering information you need to put GRAMIX parts to the best use in your equipment?



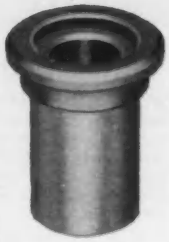


GRAMIX commutator segments

GRAMIX bearings



GRAMIX pole shoes



GRAMIX bearing inserts

GRAMIX slip rings

USG carbon graphite brushes and contacts give efficient and dependable service on all types of rotating electrical equipment. Field tests show that they can do a better job for you. Write today for catalog.

OUR 100th YEAR

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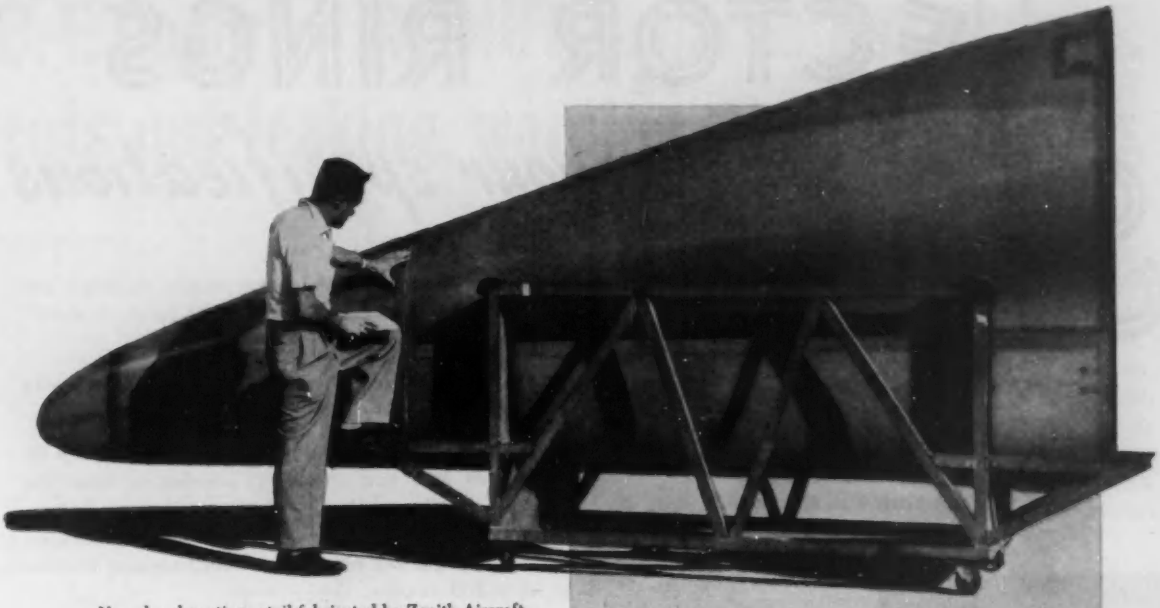
DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN



Navy bomber stinger tail fabricated by Zenith Aircraft—Division of **Zenith Plastics Co.**, Gardena, California.

Can *your* designs duplicate this 80% saving with REINFORCED PLASTICS?

Five of these big reinforced plastic stinger tails for the price of one made from conventional materials! The tails carry submarine detection devices for the Lockheed P2V Neptune.

The great savings result from fewer engineering man-hours at the design stage, use of less expensive tooling and manufacturing equipment, greatly simplified fabrication techniques, even for complex designs, faster production cycles, and the need for considerably less factory floor space.

And look at the size—seventeen feet long! Virtually no stringers, frames, bulkheads or fittings are used.

Reinforced plastics, made with glass cloth and BAKELITE Polyester Resins, are so strong that this structure withstood tests up to 300 per cent of its design load.

Your product may gain similar worthwhile design advantages from these properties of reinforced plastics:

- They can be easily fabricated into relatively large sections.
- They have a high strength-weight ratio.
- They possess both thermal and electrical insulating properties.
- They resist corrosion, chemicals, moisture, oil, and grease—are easy to keep clean.
- Their economies include low-cost tooling, savings in freight, assembly, and handling, and long service life.

Learn more about BAKELITE Polyester Resins for reinforced plastics. Write Dept. XC-10 for free descriptive literature.

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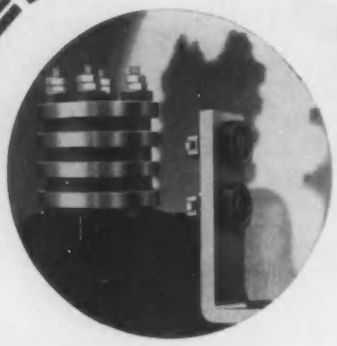
BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

COLLECTOR RINGS

to your specifications



For Electric Roll Heater

Wesche Collector Ring assemblies are usually designed and built for a specific application. They serve to complete electric circuits between stationary and revolving parts.

Typical applications are electrically heated rolls, revolving platforms or cranes and rotating parts on machinery.

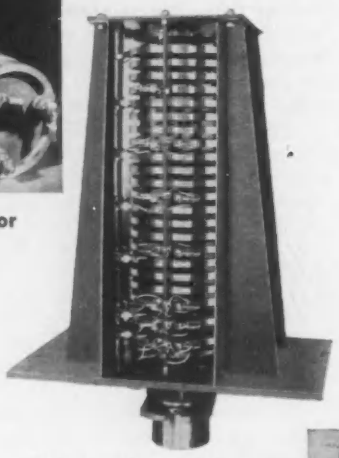
Welco Collectors are assembled with bronze rings insulated from each other with phenolic or fibre. The required number of terminals extend from one or both ends. Two to more than forty rings may be assembled into a single unit with ratings from fractional to more than 200 amperes.

Rings for Thermocouples are made of silver to reduce contact drop. Rings are made up to 48″ diameter and can be supplied split for mounting on existing machinery, such as shovels, cranes and bridges.

Space limitation is one of the deciding factors in the design of a suitable collector.

Our catalog contains a data sheet which makes it easy for you to furnish complete information on your requirements.

Three Ring Collector for Radial Drill

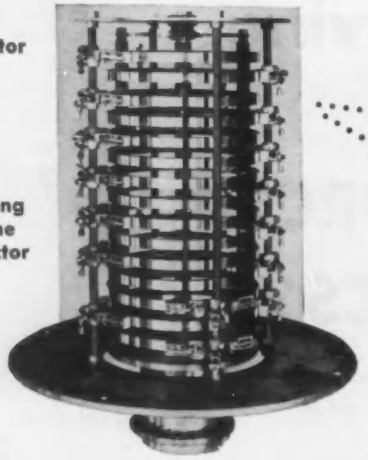


22 Ring Crane Collector

Write today for your free copy of this catalog containing data sheet and specifications for a group of standard design rings.

4 Ring Radial Drill Collector

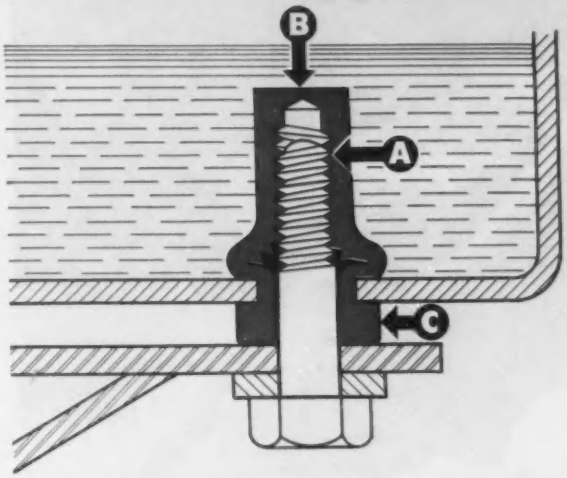
15 Ring Crane Collector



THE B. A. WESCHE ELECTRIC CO.

1624 VINE ST. **CINCINNATI 10, OHIO**

B. F. Goodrich RIVNUT replaces nut plate... cuts out leaking, warping, thread cleaning

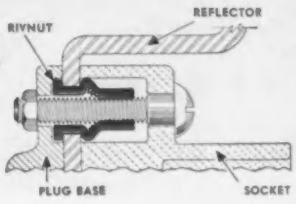


A MANUFACTURER of industrial oilers was brazing nut plates on his reservoir tanks for bolting to brackets. This sometimes caused leaks and warping. Since painting had to follow brazing, the threads had to be retapped.

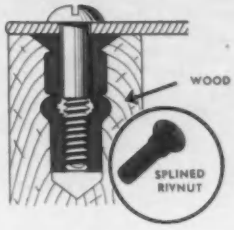
By switching to Rivnuts, brazing was eliminated. Installed from one side, after painting, in one-tenth the time required for brazing, Rivnuts provide at least six clean threads (A) to take the attachment bolt. Rivnut forms oil-tight seal, has closed end (B). Special spacer head (C) of desired height keeps spacing uniform between tank and bracket.

Closed-end Rivnut with spacer head is one of many types of Rivnuts. If you have a fastening problem, consult a Rivnut engineer. Write to The B. F. Goodrich Company, Dept. PE-54, Akron, Ohio.

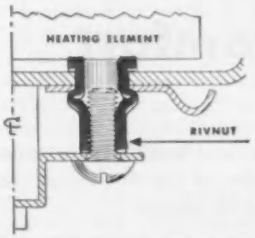
If you have fastening jobs like these, get B. F. Goodrich RIVNUTS



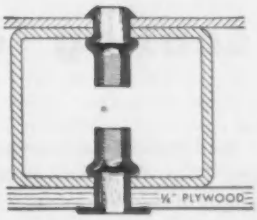
1. DOES 2 FASTENING JOBS! B. F. Goodrich Rivnuts fasten spotlight socket to reflector; same screws hold plug base to reflector. Former method demanded piercing, tapping, welding operations.



3. GIVES 6 CLEAN THREADS IN WOOD! Rivnut upset in wood eliminates wood screws, provides 6 solid threads for attachment bolt. Bulge formed by upsetting holds Rivnut fast. Splined shaft keeps it from turning.



2. ELIMINATES REINFORCING PLATE! In assembly of vaporizers, Rivnuts do away with reinforcing plate, don't turn under torque, hold flange securely without bending. Result: less assembly time, fewer parts, better product.



4. FASTENS PLYWOOD TO STEEL! Easier to install than wood or self-tapping screws, Rivnuts fasten plywood walls to tubular steel sections in trailers. No wood filler needed.

B.F.Goodrich

RIVNUTS

The only one-piece blind rivet with threads

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten TO *and* fasten WITH. Explains construction, gives proved applications . . . Write for your free copy today to The B. F. Goodrich Company, Department PE-54, Akron, Ohio.

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3M COMPANY

At the Flxible Coach Company in Millersburg, Ohio, they take great pride in the comfort of the vehicles they build.

They take great care, too, in making this comfort a lifelong feature. They use foam rubber cushioning for bus seats. And to help hold these cushions firmly in place they use a 3M adhesive, EC-164.

EC-164 secures a cloth shield backing to the rubber cushions. It also bonds the backed cushion to the metal bus seat. By using 3M adhesives instead of other fastening methods, Flxible has managed to improve the appearance and service of the finished product, and to cut production costs.

See what adhesives can do for you . . . Flxible makes use of 3M adhesives in many ways. Have you considered 3M adhesives for your jobs? Your 3M sales engineer will be glad to discuss this with you. Call him in. For a free, informative booklet, write today. Address request to 3M, Dept. 45, 417 Piquette Ave., Detroit 2, Michigan.

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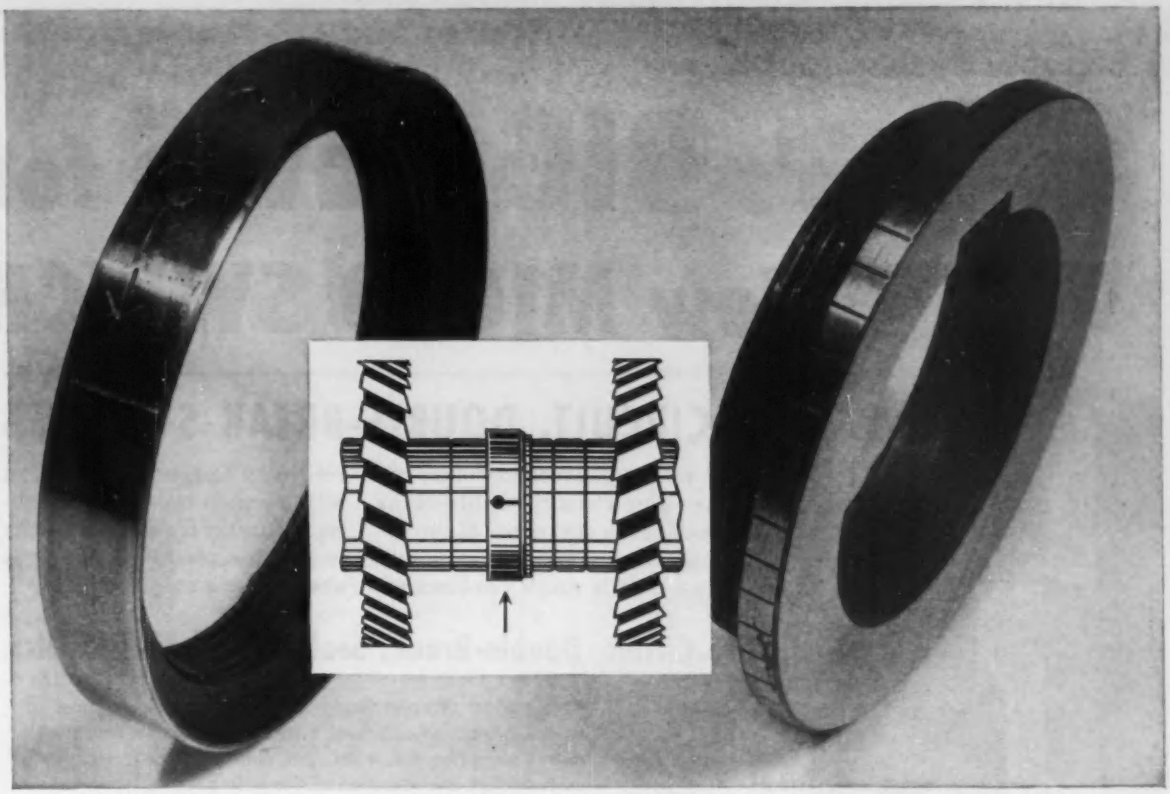


Switch to Graph-Mo® steel for spacing collars ends thread damage, eliminates thread grinding

NEAR perfect accuracy is the number 1 requirement of the Dayton Rogers Manufacturing Company, Minneapolis, for its micrometer adjustable spacing collars for milling machine cutter arbors. But when machine operators tightened the collars, they often exerted excessive arbor nut pressure that ruined accuracy and destroyed micrometer threads.

Then Dayton Rogers switched to Graph-Mo®, one of four Timken® graphitic tool steels. They found that Graph-Mo collars can take 20 tons pressure on both sides without disturbing accuracy or damaging threads. It's almost impossible for an operator to exert excessive milling machine arbor nut pressure. Micrometer accuracy is assured for the life of the spacing collars.

What's more, they discovered that the threads maintain their accuracy after heat treating. No thread grinding is necessary. Now Dayton Rogers uses Graph-Mo on all six collar sizes, from ⅛" to 1".

Users also report that Graph-Mo steel machines 30% faster, outwears other tool steels 3 to 1. It has a minimum tendency to pick up, scuff or gall. Responds uniformly to heat treatment.

For dollar-saving information on the use of Graph-Mo and other Timken graphitic tool steels for machine parts, dies, punches and gages, write for the new "Timken Graphitic Steel Data Book" just out. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD — THROUGH EXPERIENCE AND RESEARCH

TIMKEN
Fine Alloy
STEEL

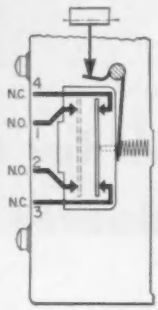
SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

MICRO SWITCH Precision Switches
A PRINCIPLE OF GOOD DESIGN

There's BIG NEWS for *New* MICRO SWITCH

TWO NEW TWO-CIRCUIT, DOUBLE-BREAK SWITCHES

MICRO SWITCH now offers two new two-circuit, double-break switches for the control of two isolated circuits. One is a heavy duty limit switch which combines exceedingly rugged construction with precision two-circuit switching. The other is a small-size basic switch for use in applications where space is at a premium.



Two-Circuit, Double-Break, Sealed Head Limit Switch

This MICRO SWITCH heavy duty limit switch combines precision, two-circuit switching, rugged construction and a sealed switch assembly. Oil, water, grit, chips or other foreign matter cannot affect the operation of this switch.

The basic switching unit is enclosed in a sturdy aluminum housing which protects the switch from physical damage and insures accurate repeatability throughout a long, trouble-free life.

It can be mounted in almost any position in relation to the means of actuation. The roller arm actuator is adjustable through 360 degrees at intervals of .4 degrees to any of 870 positive lock positions. The actuating head is adjustable to four positions at 90 degree intervals. Captive cover screws prevent loss of screws while switch is being wired or mounted.

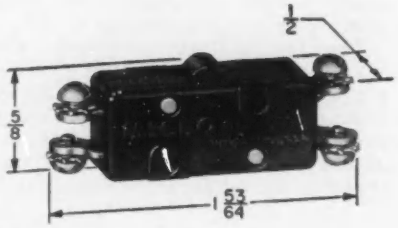
This switch is rated at 10 amperes, 110, 220 or 440 volts a-c. Pilot duty rating is 6 amperes, 125 volts a-c.

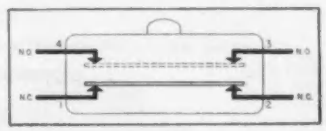
Two-Circuit, Double-Break Basic Switch

The MICRO SWITCH two-circuit, double-break basic switch is designed for either mechanical or manual operation. It is a single-pole, double-throw switch and center-actuated.

By use of a snap-action spring, almost simultaneous make and break of both contacts is accomplished in both the normally-closed and normally-open circuits. The switch is supplied with either solder or screw terminals.

The MICRO SWITCH two-circuit, double-break basic switch will switch 10 amperes at 125 or 250 volts a-c, and 10 amperes at 30 volts d-c, inductive.



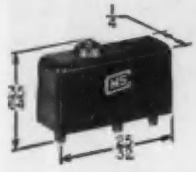


Explosion-Proof and General Purpose Limit Switches

MICRO SWITCH provides a full line of Explosion-Proof and General purpose Heavy Duty Limit Switches for every type of operating and environmental condition. Available for roller arm, plunger, or adjustable roller plunger actuation. For full information, contact your nearest MICRO SWITCH branch office.

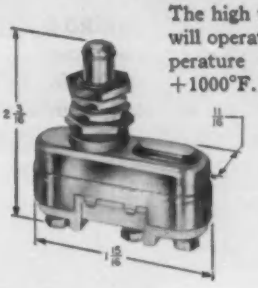
Design Engineers in these Products!

Long-Life Subminiature Switch



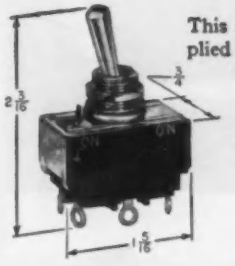
Tests show that this subminiature switch is capable of operations in excess of 20 million. It is an improved type of the basic subminiature switch and is available with either solder post or turret type, wrap-around terminals.

High Temperature Switch



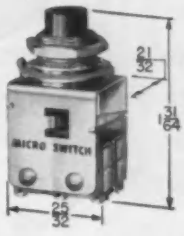
The high temperature basic switch will operate satisfactorily in a temperature range of from −50° to +1000°F. Originally designed for jet aircraft applications, it is equally useful for any application which requires a high-temperature switch.

Sealed Toggle Switch



This sealed toggle switch is supplied with an external panel seal and an internal bushing seal below the bat handle. It has a bushing for panel mounting and may also be supplied with keying tab.

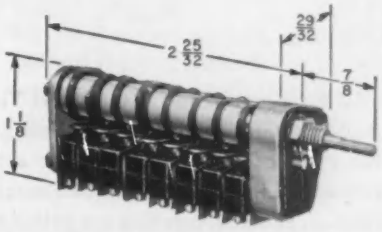
Subminiature Push Button Switch



The subminiature push button switch assembly is composed of two single-pole, double-throw subminiature switches. The switch provides an improved "feel" and simultaneous make and break of the two circuits.

Let a MICRO SWITCH Engineer Help You Select the Switch to Meet Your Needs

MICRO SWITCH field engineers, fully experienced in every type of industrial switching problem, are located at 16 MICRO SWITCH branch offices to consult with you on your switch application problem. Call on them for help without obligation. It may save you time and money.



Subminiature Rotary Selector Switch

The subminiature rotary selector switch uses from 2 to 8 single-pole, double-throw subminiature switches to control multiple circuits. It permits 2 to 8 switching positions with spring or manual return to neutral position.

MICRO SWITCH provides a complete line of extremely reliable, small-size, high-capacity, snap-action precision switches and mercury switches. Available in a wide variety of sizes, shapes, weights, actuators and electrical characteristics. For all types of electrical controls.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

FREEPORT, ILLINOIS

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Automatic Manufacture of Automotive Fuel Lines

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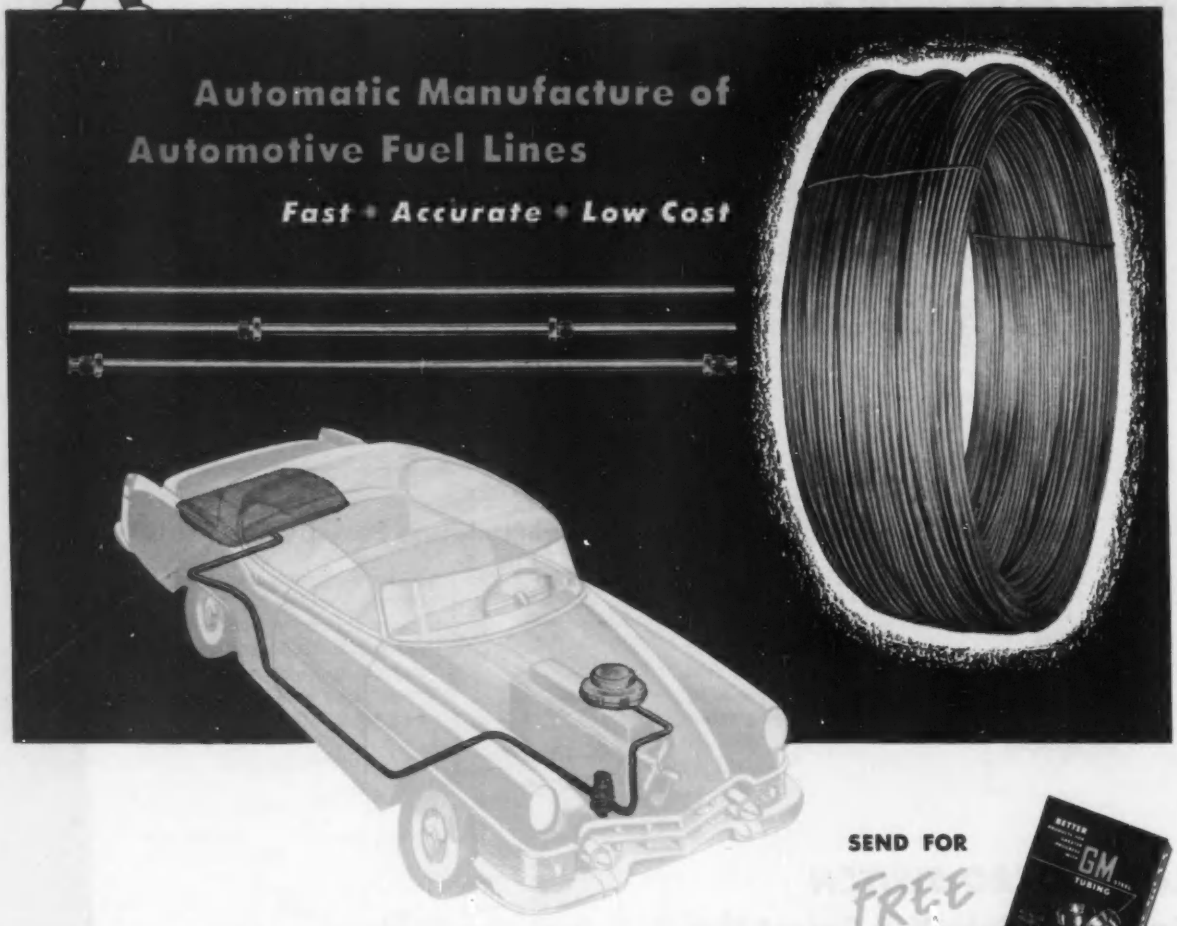

FROM the initial long-length coil of GM Steel Tubing to the final intricately formed product, complete with fittings and flared ends, the manufacture of Rochester Products *automotive fuel lines* is virtually *automatic.* Ingeniously designed machines assure *better, faster* production . . . effect *savings* that are *passed on* to the buyer!

This is a typical example of how Rochester Products engineers combine ideas, skill, experience and GM Steel Tubing to help hundreds of industries build *better products* for *less money.* Why not find out now how we can help *you?*

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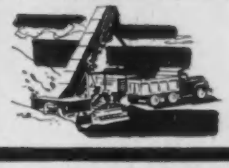
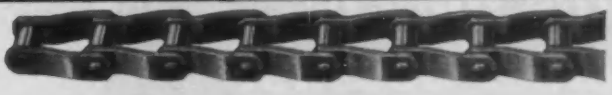
in your DRIVE for lower costs



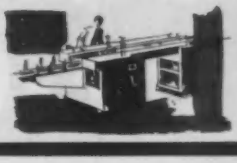
for construction machinery

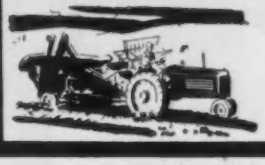


Chabelco® Steel Chain

Roller Chain

for packaging machinery





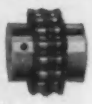
for farm implements

Pressed Steel Detachable Chain

Leaf Chains

for lift trucks

for flexible couplings



SHAFER

for self-aligning bearings

And for any drive application, Chain Belt has a size and type of chain and sprocket that can help you in your drive for lower costs. Your Chain Belt District Sales Engineer will be happy to assist you in your drive and conveyor chain, sprocket, flexible coupling, and self-aligning roller bearing selections to get lower costs, improved performance and longer life. Call him or mail the coupon below today.

Always the one best chain for each service

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I want data on chains for a.....

☐ Send literature on: ☐ Chabelco Chains; ☐ Roller Chains; ☐ Detachable Chains; ☐ Double Pitch Chains; ☐ Leaf Chains; ☐ Flexible Couplings; ☐ Bearings; ☐ Sprockets.
☐ Have a Chain Belt Man call.

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Company.....

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City.....*Zone*.....*State*.....

the tone is clear because the design is simple . . . with

DIE-CASTING

CASE HISTORIES FROM MT. VERNON FILES

A greatly improved Hi-fi Speaker — at a reduced manufacturing and assembly cost—are the benefits University Loudspeakers, Inc., gain from the design of their new wide-angle reproducing trumpet, Cobreflex-2.

This effective design was made possible by die casting; one part replaces three spun sheet metal parts previously needed in their other horns. The trumpet assembly combines two identical aluminum die castings, to produce a pair of exponential horns having twin air columns in a single assembly. A "dual exponential flare design", University calls it—its advantages: a smooth, even radiation pattern of sound, free from the cancellations that come from cellular and multi-mouth horns. Tone arm and reflectors being integral, there are no separate parts to loosen and vibrate.

Yes, die casting keeps construction *simple* . . . and in almost any manufactured part, simplicity gives the best results. Die casting can be done to extremely close tolerances, frequently eliminating the need for machining. This too brings costs down.

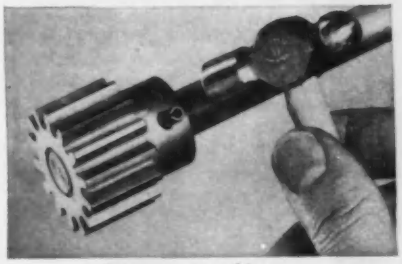
Whatever *your* product, you can almost certainly profit by considering the advantages of die casting; light weight, simplicity, lower costs. You may find, as did University Loudspeakers, that an improved new design is made possible. Our varied experience of many years is wholly at your service. Let us know your needs today.

MT. VERNON
DIE CASTING CORP.
STAMFORD, CONNECTICUT

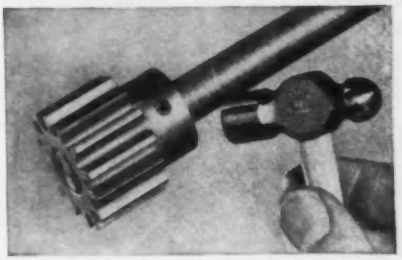
Where can you use this simple fastener?

Rollpin is driven into holes drilled to normal production-line tolerances.

No threading, peening or precision drilling with ROLLPIN



It compresses as driven.



Rollpin fits flush . . . is vibration-proof.

Rollpin is the slotted tubular steel pin with chamfered ends that is cutting production and maintenance costs in every class of industry.

This modern fastener drives easily into standard holes, compressing as driven. Its spring action locks it in place—regardless of impact loading, stress reversals or severe vibration. Rollpin is readily removable and can be re-used in the same hole.

* * *

If you use locating dowels, hinge pins, rivets, set screws—or straight, knurled, tapered or cotter type pins—Rollpin can cut your costs. Mail our coupon for design information.

Elastic Stop Nut Corporation of America
Dept. R16-52, 2330 Vauxhall Road, Union, N. J.

Please send me the following free fastening information:

☐ Rollpin bulletin
☐ Elastic Stop Nut bulletin
☐ Here is a drawing of our product. What fastener would you suggest?

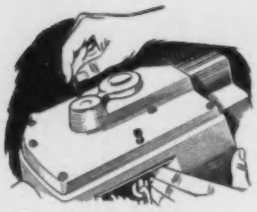
Name _____ Title _____

Firm _____

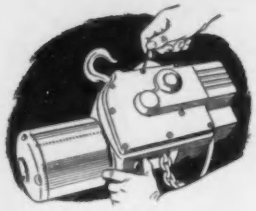
Street _____

City _____ Zone _____ State _____

23 UNBRAKO Socket Head Cap Screws are used to assemble this lightweight, high efficiency electric hoist. They were selected for their uniform accuracy and high tensile strength.



The knurling on the head of UNBRAKO Socket Head Cap Screws permits faster assembly, because of the positive slip-proof grip.



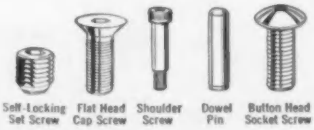
The uniform depth and size of the hex socket assure strength and maximum torque in wrenching—extremely important in the cap screws used to fasten assemblies like this.

UNBRAKOS—made of heat treated alloy steel—have fully formed threads, Class 3 fit; controlled fillet and continuous grain flow for strength. In standard sizes from # 4 to 1".

Save time and money by using UNBRAKO Standards...stocked by your distributor

You'll have less money tied up in inventory, you'll need less space for storage, you'll get personalized service and faster deliveries. And you'll be buying the finest socket screw products that modern machines, complete facilities and quality control can produce. Write for UNBRAKO Standards, a complete listing of socket screw products made by the world's largest producer. STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

UNBRAKO® SOCKET SCREW DIVISION SPS JENKINTOWN PENNSYLVANIA



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helps you design the advantages of

ALEMITE OIL-MIST

into any machine...in minutes!

Here's the simple, easy way to specify Alemite Oil-Mist—to make sure your machines have the tremendous advantages offered only by this most modern method of lubrication.

It's easy to measure the lubrication requirements of *any* machine you are designing! Just set the Oil-Mist slide rule as required—for anti-friction bearings, plain bearings, slides, ways, vees, chains or gears—and immediately the proper application information appears.

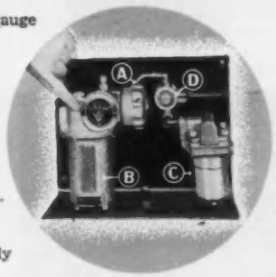
You see at a glance the type of fitting to use—how to compute bearing surface—how to take full advantage of the amazing capacity and flexibility Oil-Mist offers you! Includes basic lubricant recommendations and a complete schematic diagram showing tubing, fittings, tees, unions.

Save time and work in specifying and detailing Oil-Mist, the most efficient machine lubrication ever devised! Clip, fill out and mail coupon NOW. Supply limited!

Alemite Oil-Mist offers these lubrication advantages

Automatic Lubrication • Continuous Lubrication
Eliminates Guesswork • Greater Safety • Cuts Oil Consumption up to 90%
Extension of Bearing Life • Stops Oil Drippage • Reduction of Bearing Temperatures • Manpower Savings • Elimination of "Down-Time" Reduction in Number of Lubricants • Protection from Contamination

LUBRICATOR SPECIFICATIONS:



- Oil-Mist outlet ½" fem. p.t. Air gauge registers to 50 psi. Operating air pressure—5 to 20 psi.
- Air regulator (A) reduces from pressures up to 200 psi. Normal air consumption—.7 to 1.2 cfm.
- Range of oils handled—to 1,600 sec. (S.U.V.) @ 100°F.
- Oil reservoir (B) capacity 12 oz. (approximately 1 week supply). Intake filter screen—70 mesh. Fill plug—9/16".
- Material—die cast aluminum body with nylon plastic window.
- Baffle-type water separator (C)—automatic self-dumping. Requires no manual attention—no filter elements to replace. Air inlet ¼" fem. p.t.
- Solenoid Control (D) starts system automatically when machine starts—foolproof.

A PRODUCT OF SW STEWART WARNER

Alemite OIL-MIST Lubrication

Delivers Oil to Bearings 3 Ways!

Oil-Mist Fittings bring the most efficient lubrication in the world to any anti-friction bearing—ball, roller or needle.

Spray Fittings are recommended for open and enclosed gears and chains. Allow for a concentrated spray of oil where it is needed.

Condensing Fittings apply oil in liquid form to plain bearings, slides, ways, vees, cams and rollers.

FREE! Fill out—mail this coupon!

ALEMITE, Dept. T-54
1850 Diversey Parkway, Chicago 14, Illinois

Gentlemen: Please send me my Oil-Mist Slide Rule and up-to-date information on Oil-Mist. No obligation.

Name _____

Company _____

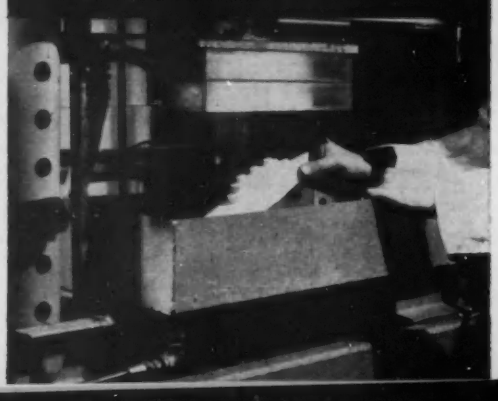
Address _____

City _____ State _____

SO MUCH FROM SO LITTLE. Before and after expansion—this small pile of beads has been blown up to about 30 times its original size. The weight remains the same.

SEE THOSE BEADS. This picture shows the magnified plastic beads that expand to form a variety of shapes and sizes.

POP GOES THE POLYSTYRENE. A simple molding machine, Koppers Expandable Polystyrene and a little heat are all that is needed to make any shape you need. The smooth, white surface of the foam does not require finishing.



PLAIN OR FANCY. Expandable polystyrene rises to fill intricate molds. Molded pieces can be painted if desired.

Amazing new Polystyrene can be expanded to shape

Koppers Expandable Polystyrene makes tough foam that insulates, floats

NEW Koppers Expandable Polystyrene looks like granulated sugar. But, when a handful of it is poured into a simple mold and heated, the polystyrene rises to fill the entire cavity. It forms millions of small plastic cells, all joined together to make a tough, strong foam. Open the mold and you have a foamed polystyrene piece, smooth and light and in the shape and density desired.

By controlling the *quantity* of polystyrene placed in the mold, the density and physical properties of the expanded plastic may be varied as desired. The heavier material is stronger because it has a tighter network of small, thick walled plastic cells. Lightweight products have larger cells, and a higher insulating value.

Koppers Expandable Polystyrene can be molded into a variety of shapes for low temperature insulation — refrigerators, freezers, air conditioners and piping. Also, this new polystyrene is just the thing for life rafts, buoys, packaging, toys and displays. Use it in products that need light weight, insulating properties, buoyancy, strength, smoothness, paintable surfaces, low water absorption, and precisely molded contours.

For more information about Koppers Expandable Polystyrene, fill out and mail the attached coupon.

Be sure to see this new Polystyrene at the Plastics Show— CLEVELAND, OHIO, JUNE 7 THRU 10.

Koppers Company, Inc.
Dept. PE-54, Chemical Division
Pittsburgh 19, Pennsylvania

Please send me further information on Koppers Expandable Polystyrene ☐

Name.....

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City.....State.....

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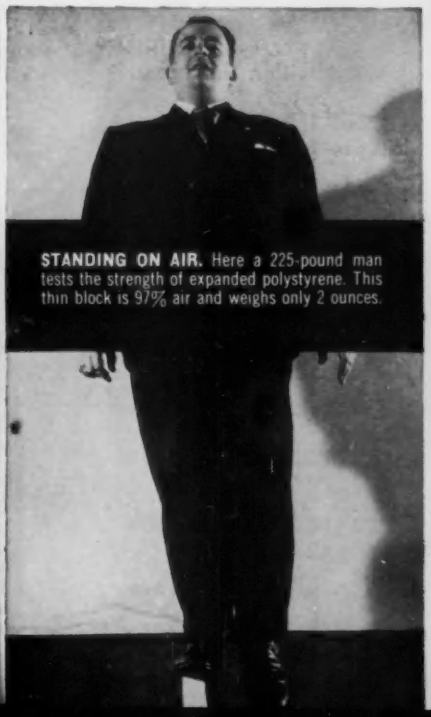
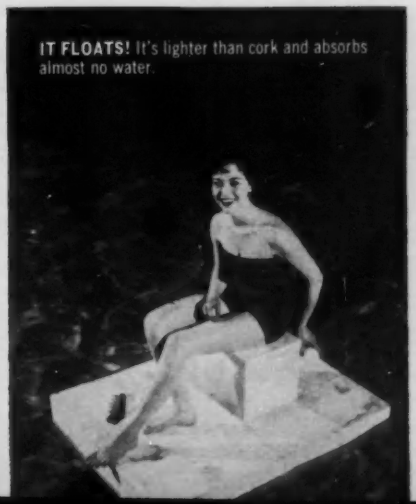
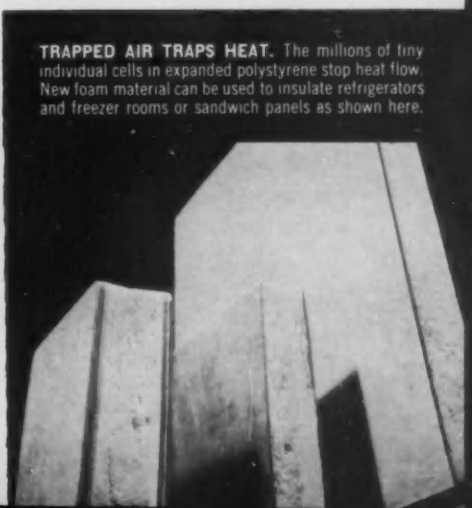


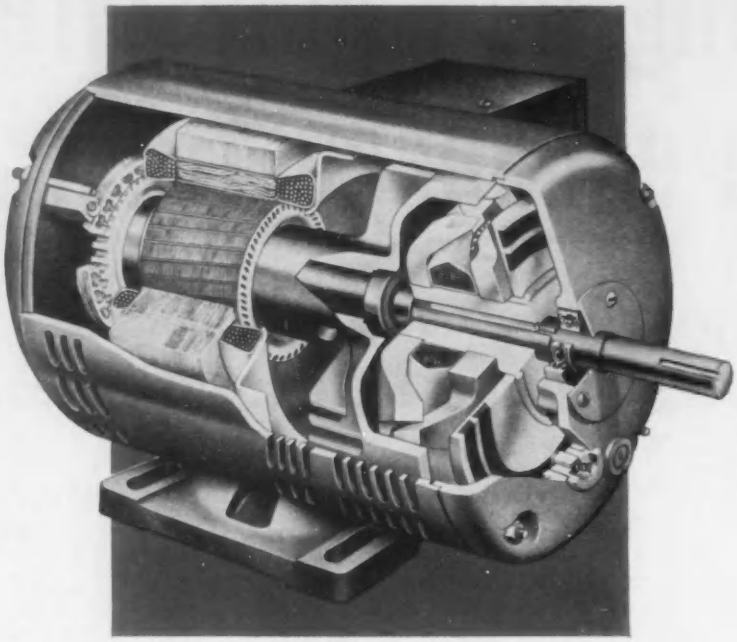
STANDING ON AIR. Here a 225-pound man tests the strength of expanded polystyrene. This thin block is 97% air and weighs only 2 ounces.



IT FLOATS! It's lighter than cork and absorbs almost no water.



TRAPPED AIR TRAPS HEAT. The millions of tiny individual cells in expanded polystyrene stop heat flow. New foam material can be used to insulate refrigerators and freezer rooms or sandwich panels as shown here.



Now—Dynamatic Makes Ajusto-Spede Motors Available in Fractional Horsepower Sizes

The addition of 5 new fractional horsepower models to the existing Ajusto-Spede line extends the available range of these adjustable speed drives from ¼ horsepower to 75 horsepower.

This compact, self-contained unit is an integral combination of AC constant speed induction motor, eddy current coupling, and electronic control.

All fractional horsepower Ajusto-Spedes are rated 115/220 volts, single phase or 220/440 volts, 3 phase. Sizes are ¼, ⅓, and ½ horsepower at 1600 RPM; ½ and ¾ horsepower at 3200 RPM.

If you have fractional horsepower adjustable speed drive problems, write for a copy of the Dynamatic Bulletin FAS-2. Bulletin GB1, which describes other Dynamatic Eddy Current products, is also available.

Ajusto-Spede Advantages:

- ★ **Constant torque speed range: 10 to 1 with 1600 RPM Ajusto-Spedes; 20 to 1 with 3200 RPM units.**
- ★ **Control accuracy: 2 per cent of top speed at any point within the speed range.**
- ★ **Minimum wiring to power line.**
- ★ **Remote "one knob" control operation up to 100 feet.**
- ★ **Rugged plug-in type integral one-tube electronic control.**
- ★ **Permanently sealed grease-packed bearings.**
- ★ **Power output shaft extension at both ends of drive.**

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KENOSHA, WISCONSIN • General Offices: Cleveland, Ohio

NOW! Radically different shaft seal for extreme dust and dirt conditions!

NATIONAL TRIPLE-LIP SYNTECH® SEAL

Low cost*, easy to install
Excludes all dirt, mud, water
Ideal for flush lubrication
Effective after 4,000 test hours
Seals under severe runout

John Deere-Killefer *Disk Harrows are now equipped with heavy duty Fafnir ball bearings protected by National Triple-Lip Syntech Seals. The new assembly reduces friction and drag, increases bearing life, and requires lubrication only once every 300 hours or once a year in normal use!*

National Triple-Lip Syntech is a completely different type of shaft seal providing a new standard of bearing protection for equipment operating in severe dust, dirt, mud or water conditions.

The seal is extremely simple in design, low cost, and easy to install. It consists of three identical synthetic rubber sealing members bonded to metal washers and enclosed in a rigid steel outer case. The sealing members are National Syntech, dependable, all-purpose synthetic rubber compound.

Use of thin Syntech sections as sealing lips keeps torque low, makes flush lubrication easy, and enables the seal to accept a large amount of runout and misalignment.

For complete information, call your National Applications Engineer or write direct.

*Compared to most conventional, multiple-lip seals.

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OIL & GREASE SEALS
O-RINGS SHIMS
®

NATIONAL MOTOR BEARING CO., INC.
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DALLAS, TEXAS . . . *30½ Highland Park Village, JUstin 8-8453*
DETROIT, MICH. . . . . *726 Lothrop Avenue, TRinity 1-6363*
DOWNEY (Los Angeles Co.), CALIF. . *11634 Patten Rd., TOpaz 2-8166*
MILWAUKEE, WIS. . . *647 West Virginia Street, BRoadway 1-3234*
NEWARK, N. J. . *Suite 814, 1180 Raymond Blvd., MItchell 2-7586*
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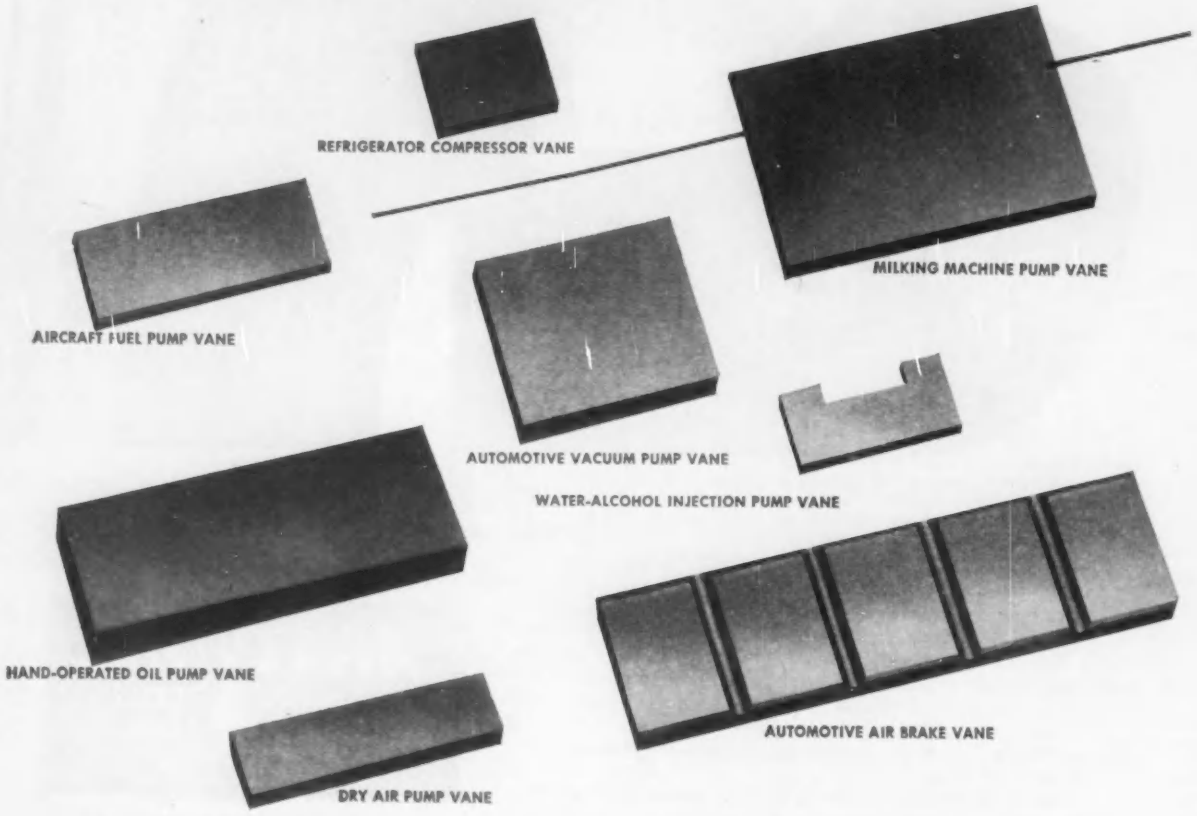
ARE PROVING THEIR SUPERIORITY IN SERVICE

Rotary pumps, compressors, air motors, vacuum pumps and similar machines equipped with GRAPHITAR vanes function efficiently, give long service and require little or no maintenance. For GRAPHITAR vanes are self-lubricating and can operate under loads at high speeds without oiling. GRAPHITAR vanes are self-lapping and adjust to their wear. GRAPHITAR is chemically inert and does not corrode—even when pumping strong acids or alkalies. GRAPHITAR is unaffected by atmospheric changes, high speeds or temperature extremes. To date, more than 25,000,000 of these vanes are operating efficiently in automotive, aircraft, farm, and household appliances. GRAPHITAR vanes can be supplied in a variety of grades and precision ground to tolerances as close as .0005". For complete information, write us today.

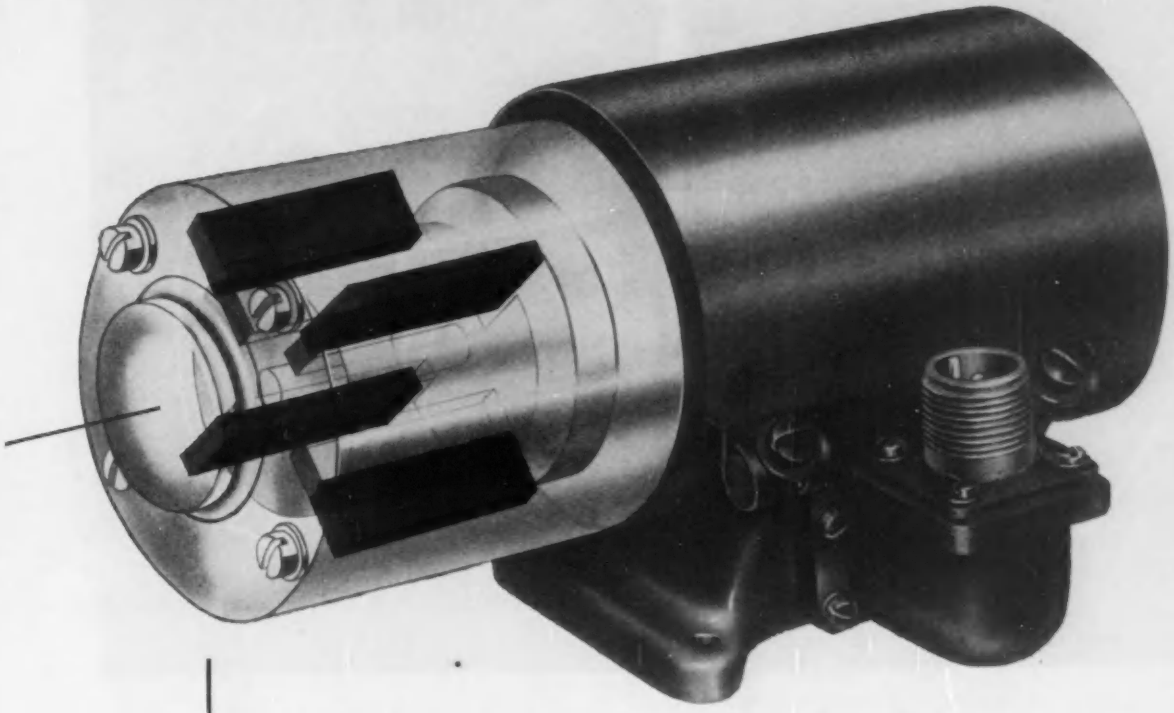


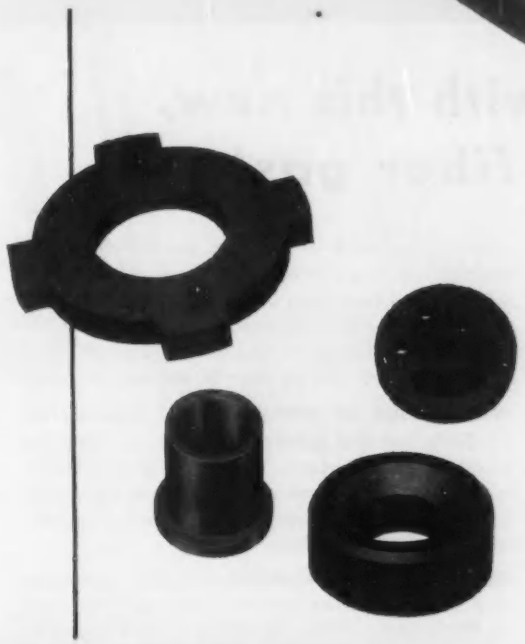
OUR 100th YEAR

THE UNITED STATES

GRAPHITAR® VANES

(CARBON-GRAPHITE)





GRAPHITAR seals, bearings, piston liners and other parts (as well as GRAPHITAR vanes) are produced from carbon-graphite powders, compacted under high pressures and furnaced at temperatures up to 4500° F. GRAPHITAR can be formed in relatively complicated shapes and ground to tolerances as close as .0005". GRAPHITAR is lightweight, strong and durable, self-lubricating, chemically inert and virtually unaffected by high speeds, high pressures, heat or cold. In hundreds of difficult applications, GRAPHITAR has proved to be the only completely successful material. Write today for illustrated 64-page catalog.

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GRAPHITE COMPANY

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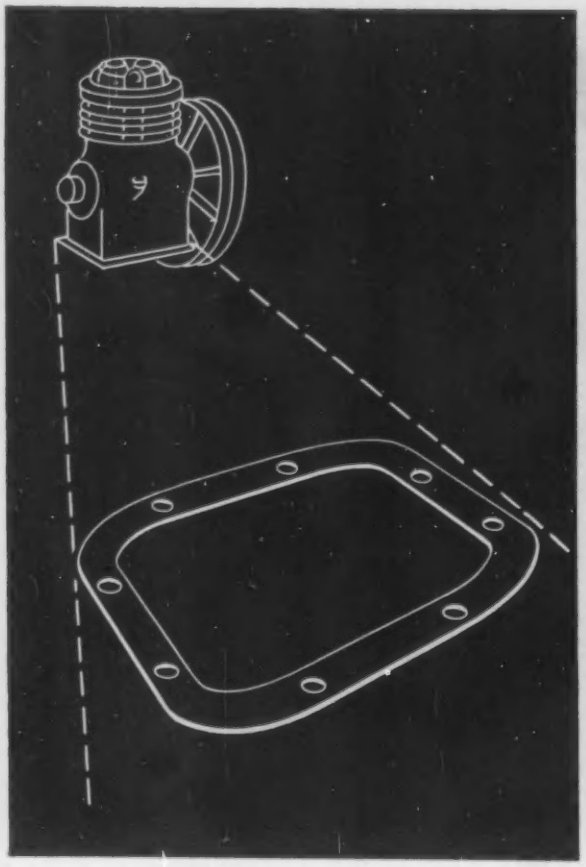

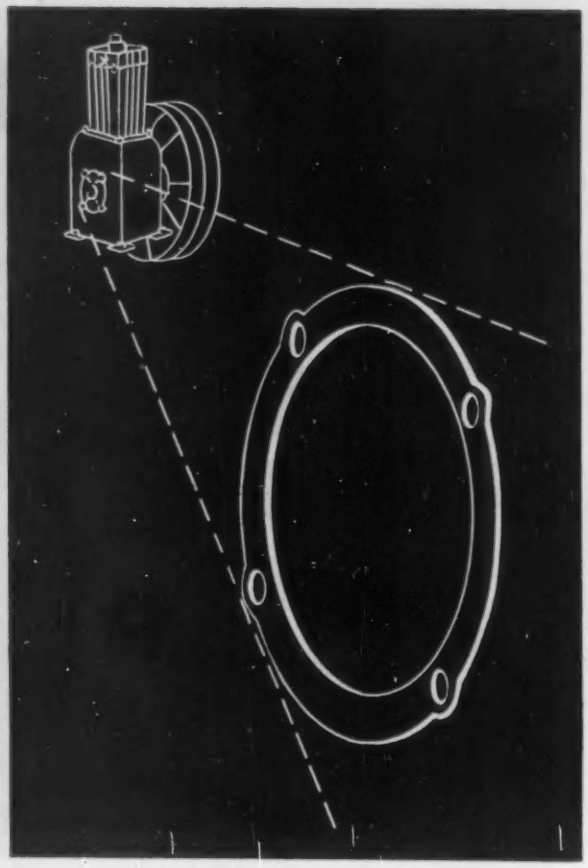

No oil leakage with this new, non-shrinking fiber gasket

Leaky gaskets don't always interfere directly with an air compressor's operation, but they do bring in a lot of complaints. One compressor manufacturer had exactly this trouble with oil pan and bearing carrier gaskets made from a conventional fiber sheet. Oil and oil vapors leached out the binder, causing the gaskets to dry out, shrink, and leak.

He found an effective, economical solution by changing to an entirely new kind of fiber gasketing —Armstrong's Accopac®. Accopac is a beater-saturated material made with a non-extractable rubber latex binder. It *can't* dry out, shrink, or harden in any recommended application.

Accopac CN-705 gaskets are now specified on these compressors, improving their appearance on the job, reducing customers' cleaning and maintenance costs, and cutting down complaints greatly.

WON'T SHRINK OR DRY OUT. Accopac gives good results in this kind of service because of the way it's made. Fiber, cork, and rubber are literally locked together by a patented beater saturation method which makes each sheet uniformly strong and homogeneous. Thus, Accopac gaskets are impervious and remarkably resistant to dimensional change. Even after months of storage, they fit and seal perfectly.

WIDE RANGE OF APPLICATIONS. Wherever dependable, low-cost sealing is required, Accopac has found ready acceptance. It's being used today in pumps, engines, aircraft and automotive equipment, household appliances, and in an ever-increasing variety of similar applications.

FREE 1954 GASKET MANUAL—For full information on Accopac and other versatile gasket materials, write for the 24-page manual, "Armstrong's Gasket Materials." It contains latest information on specifications, plus data on cost reduction, gasket tolerances, flange and joint design, etc. See it in Sweet's product design file, section 3h or write Armstrong Cork Co., Industrial Division, 7005 Irvin Street, Lancaster, Pa.

ARMSTRONG'S ACCOPAC

KIEKHAEFER

MERCURY

15th Anniversary Models

G.S. GEARS FOR 15 YEARS

Gearing of *finest* quality has always been demanded by KIEKHAEFER Corporation of Fond du Lac. Extreme accuracy and rigid adherence to critical specifications have applied from the first MERCURY made, to the brilliant 1954 line. Throughout "Fifteen Fabulous Years" G. S. Gears have helped MERCURY gain a position of quality leadership unequalled in the history of the industry!

Big features of the "Mighty Mark 50" pictured here, are new standards of speed, power and performance. 4 cylinders . . 40 horsepower . . *today's most powerful outboard!* To take speed and power like that, successfully, *the Gearing has to be good!*

Congratulations to KIEKHAEFER Corporation on the occasion of their 15th Anniversary. We at G. S. are thankful for the opportunity to serve.

GET OUR *Free* 6-PAGE FOLDER

See where and how we mass-manufacture Small Gearing to uniformly fine tolerances. This attractively printed 8½ x 11" 6-page folder is punched for ring-binder use. You'll want to keep it handy for frequent reference. It contains 23 pictures of Small Gears, plant views, as well as Diametral and Circular Pitch Tables. Ask for your copy on company stationery, please!

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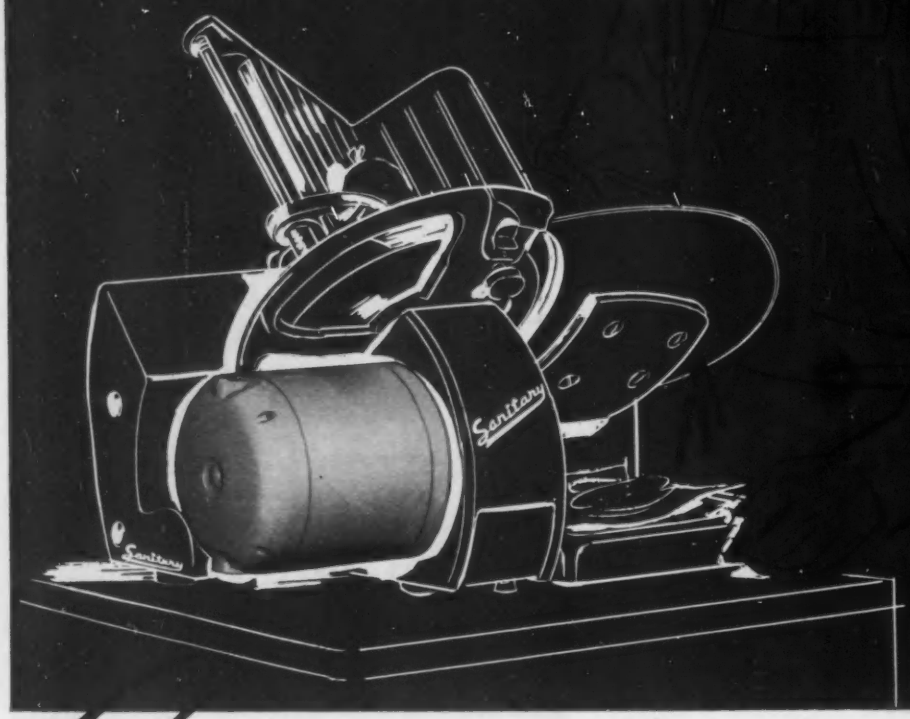
WORLD'S LARGEST EXCLUSIVE MANUFACTURERS
OF FRACTIONAL HORSEPOWER GEARING

HOW JACK & HEINTZ BUILDS MOTORS

HERE WAS THE PROBLEM

This is a typical J&H *Customized* Motor that powers the well-known Sanitary Scale Food Slicer. Attractive and efficient, it was styled for this application, complementing the food slicer in every detail. The motor requirements called for low noise level, complete freedom from vibration, special high thrust provision with minimum shaft end play and a rigid face-mounted end bell. The motor was totally enclosed to meet rigid sanitation requirements.

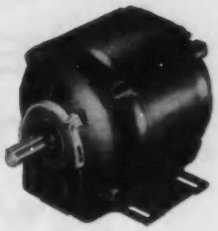


Customized JACK & HEINTZ

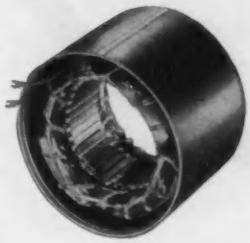
TO FIT THE *Sanitary* SLICER

J & H CUSTOMIZED MOTORS ARE DEVELOPED FROM STANDARDS

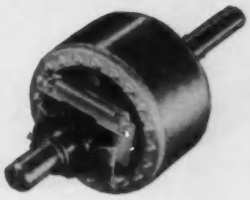
In custom designing a motor for an original equipment manufacturer, J & H engineers start with a basic motor. This is the step-by-step story, from one end bell to the other, of the evolution of a J & H *Customized* Motor.



A new cast-iron, face-mounted end bell features machined pilots for holding tolerances required for Sanitary's gear reduction drive.

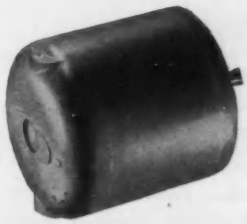


Special low flux-density winding for extremely low noise level used in this heavy-gauge stator ring assembly.



A special shaft machined to Sanitary's requirements is assembled to a rotor core. Thrust assembly assures limited end play.

Selected for streamlined contours, this switch end bell facilitates ease of cleaning, further accentuates smooth lines of entire motor.



Here is the result—a *Customized* Motor with eye appeal, incorporating electrical and mechanical features designed to make it an integral part of Sanitary Scale's attractive slicer.

Design your product to do a job . . .

not to fit a motor

Avoid those "standard" motor compromises in your product through an engineering philosophy that's geared to solve your special needs. *Design your product to do a job . . . not to fit a motor!* Write Jack & Heintz, Inc., 17627 Broadway, Cleveland 1, Ohio.

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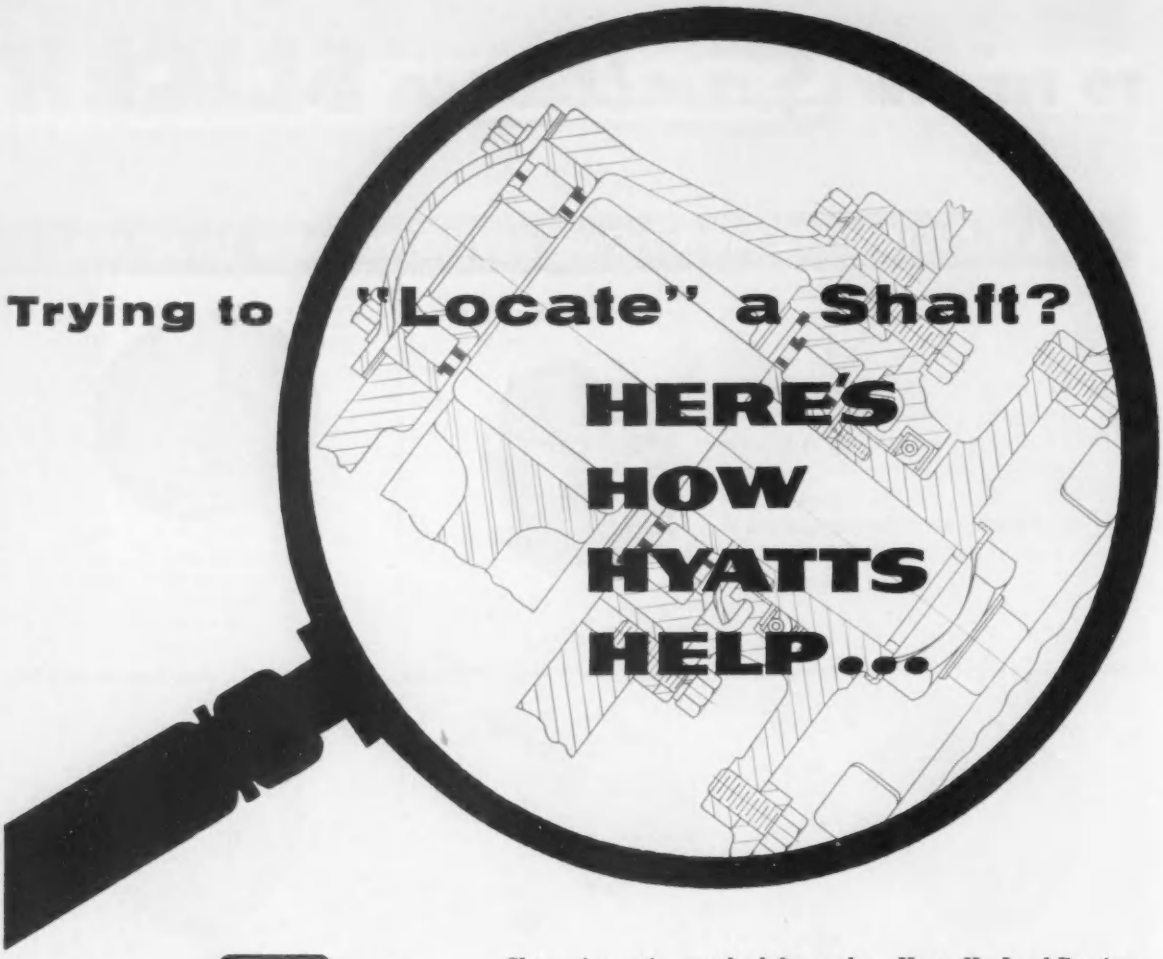
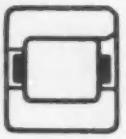
ELECTRIC MOTORS

Trying to "Locate" a Shaft?

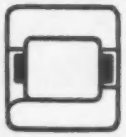


HERE'S HOW HYATTS HELP...

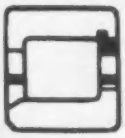
3 TYPES



BU-L separable outer race series



R-WB separable inner race series



R-YS separable inner race series

Shown in section at the left are three Hyatt Hy-Load Bearing types that are used for axial shaft location. Flanges on inner or outer races limit axial shaft movement and permit the bearing to take light, intermittent thrust loads.

Since Hyatt inner races are assembled on shafts, with relatively heavy press fits, no accessory parts are necessary to hold them in place.

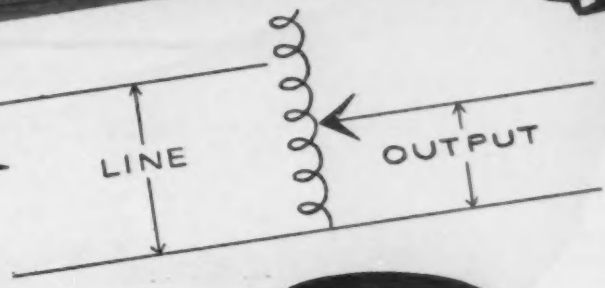
Hyatt Hy-Load Bearings are available with a variety of combinations of race flanges, snap rings, cages or separators, so that just the right combination can be selected for each set of operating conditions.

Hy-Loads are available in three diameter series, two widths and a complete range of sizes. For complete information write for Catalog 150—Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

STRAIGHT BARREL TAPER

For Designs that Require Adjustable A-C Voltage



Put this symbol in your circuit and a POWERSTAT Variable Transformer in your products and you'll get:—

...Cool operation

...Power savings..high efficiency

...Does not have to be tailored to the load

...Smooth control—glass smooth commutator surface

...Conservative ratings and easy, simple mounting

In many applications where you might usually use a rheostat, *investigate Powerstat variable transformer to do a better job* — and you can get a Powerstat for as little as $8.50.

You'll find Powerstats are superior. Their dimensional and physical characteristics make them easier to "design into" a product. Their conservative ratings, smooth operation and long life make them a "plus" feature of value.

For the best in continuously-adjustable voltage control use variable transformers. For the best in variable transformers always specify POWERSTATS.

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Manufacturers of: Powerstat Variable Transformers • Stabiline Automatic Voltage Regulators • Voltbox A-C Power Supplies • Powerstat Light Dimming Equipment • Varicell D-C Power Supplies • Superior 5-Way Binding Posts

You can choose from a complete standard line of Powerstat variable transformers. Units are offered in manually-operated and motor-driven assemblies for 120, 240 and 480 volt duty in capacities from 150 VA to 100 KVA.

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1905 Clarke Avenue, Bristol, Conn.

Please send complete literature on Powerstat variable transformers.

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Company Address.....

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Progress is built

Fairbanks-Morse will also continue to supply electric motors in *old* NEMA frame sizes.

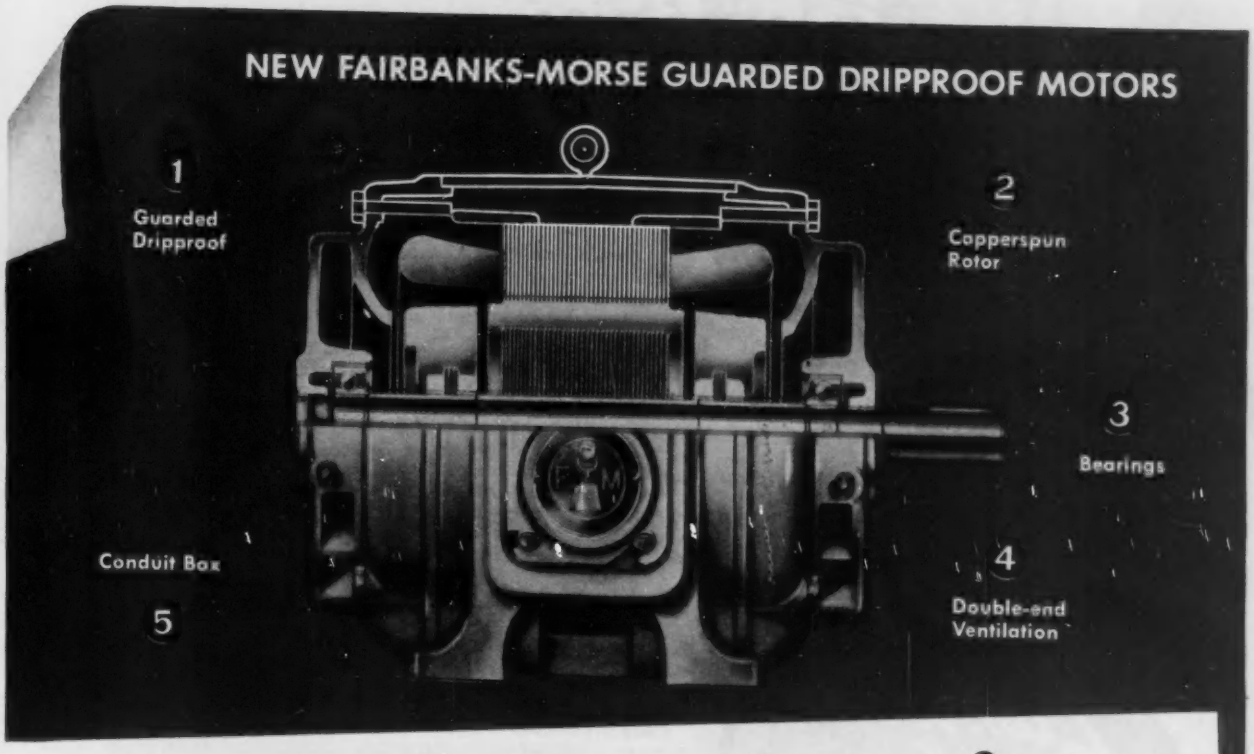
. . . brick by brick

The new NEMA Standard for electric motors is a significant sign of progress to all industry—More Power in Less Space.

But progress—to be lasting—must be built brick by brick
For more than a century, Fairbanks-Morse designers have held to the ideal of more performance in less space. They have produced outstanding advancements in the design of diesel engines, pumps, scales, locomotives and the many other products that feature F-M exclusives. Fairbanks-Morse electric motors built on this basic F-M engineering philosophy are continuing assurance of operating economy and efficiency.

Look for the electric motor that stands on this Fairbanks-Morse solid foundation of design progress. It carries the Fairbanks-Morse Seal of Quality.

NEW FAIRBANKS-MORSE GUARDED DRIPPROOF MOTORS



1 Guarded, dripproof construction keeps falling objects and dripping liquids out of motor in any mounting position—maximum motor protection under conditions of wet or dirty operation—indoors or out.

2 Exclusive Fairbanks-Morse feature that provides a virtually indestructible one-piece rotor—homogeneous, free from flaws and gas inclusion for maximum strength and lifetime service.

3 Oversized, precision ball bearings in spacious housings, sealed against grease leakage. Contain ample lubrication for extended periods of rugged service. Convenient flushing and re-lubricating available if desired.

4 F-M exclusive design eliminates hot spots. Cooling outside air is drawn into motor through openings in lower portion of both bearing arms and circulated through cored passages in the frame.

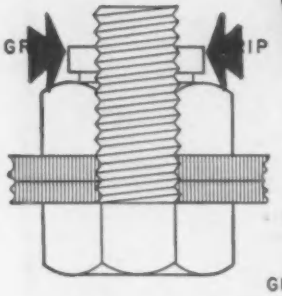
5 New, gasketed, cast iron conduit box permits easy pulling of cables without insulation damage. Fairbanks-Morse exclusive: recess feature allows elimination of conduit box where space is limited.

FAIRBANKS-MORSE
a name worth remembering when you want the best

ELECTRIC MOTORS AND GENERATORS • DIESEL LOCOMOTIVES AND ENGINES • PUMPS • SCALES • RAIL CARS • HOME WATER SERVICE EQUIPMENT • FARM MACHINERY • MAGNETOS

PROBLEM:
To effect a permanent nut and bolt fastening that will resist loosening under all conditions including severe vibration and temperature changes.

Solution: *Lamson* LOCK NUTS



U. S. PAT. NO. 2255286

Lamson Lock Nuts were designed for use where the going is rough and tough. Thus they are the ideal nuts for use where vibration is a factor . . . automotive equipment, construction machinery, railroad engines and cars and similar products.

Unlike many other lock nuts, the Lamson Lock Nut is a *one-piece all steel* nut that does not depend upon inserts or special methods of application for use.

As it is turned on the bolt, the heat-treated crown collar, slightly distorted from the round, grips the bolt firmly. When the nut is tightened the threads of the collar are forced against the "non-pressure flanks" of the bolt. Since the main body of the nut is exerting pressure on the "pressure flanks" a radial locking action results. Lamson Lock Nuts may be reused repeatedly without losing their locking action.

So, if you have a problem as stated above, consider Lamson Lock Nuts. They are the ideal solution from every standpoint.

Lamson + Sessions

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Plants at Cleveland and Kent, Ohio • Birmingham • Chicago

The facilities of our company are at your disposal to assist you with any fastener problem.

Check the products below that interest you; tear off bottom of ad and send to us for complete information.

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Fasten metal parts efficiently from one side of the work.

PIPE PLUGS
Forged steel, heat-treated.

"1035" SET SCREWS
Cup point type, hardened and heat-treated.

PLACE BOLTS
With "Built-in" spring action for positive locking.

LAMSON LOCK NUTS
Economical, vibration proof. Can be used repeatedly.

LOK-THREAD PRODUCTS
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DIAMOND LOCK SCREWS
Plastic insert locks threads. Can be reused.

WELD NUTS
For strong, always level welding.

DELCO MOTORS

the best running mate your product can have

In this pushbutton age, millions of Delco motors supply the actuating power to operate the appliances, tools and equipment that help to create our American standard of living.

This widespread use of Delco motors is convincing testimony to their outstanding, dependable performance. Popular endorsement on such a broad scale suggests that a Delco motor is the best running mate *your* product can have.

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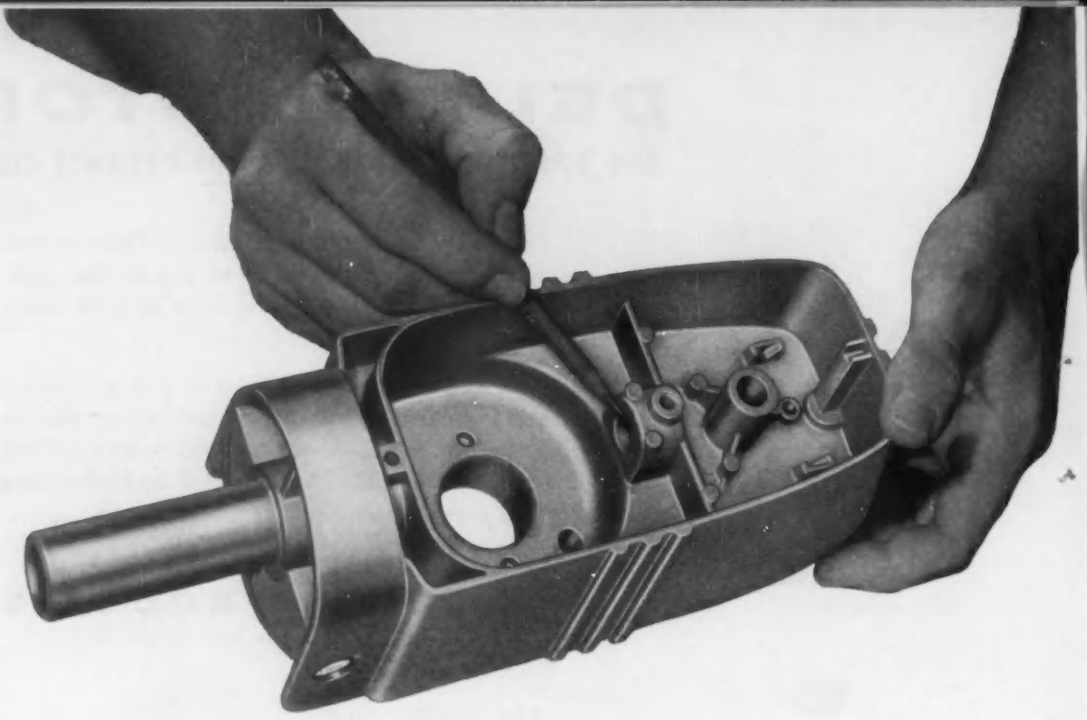

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or is it?

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In 44 years, we have produced many very difficult and unusual die castings here at *Stewart*. However, this is not one of them. Though it includes 3 inserts, this is the "garden variety"—the kind we turn out every day. But to us, no job seems ordinary, because we try to do each one a little *better* than the last. Whatever type of die castings you need—small or large, simple or intricate—with or without inserts—count on *Stewart* to meet your most rigid specifications . . . on time.

SERVICES AVAILABLE . . .

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DOW CORNING

Silicone News

No. 6 of a Series • PUBLISHED BY DOW CORNING CORPORATION, MIDLAND, MICHIGAN

Silicone Compound Protects Aircraft Heater Ignition Unit Against Moisture and Corona

Corona discharge at high altitudes and rusting caused by moisture condensation due to rapid changes in temperature in the new Janitrol aircraft heater ignition units, were reduced to a minimum by the use of Dow Corning 4 Compound.

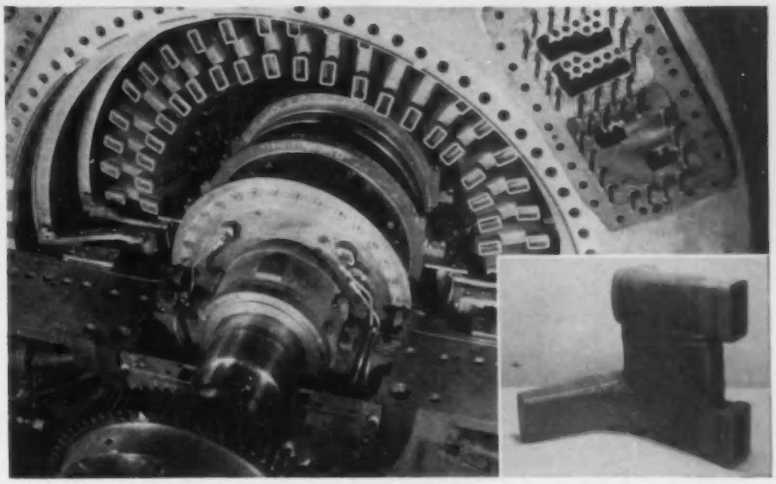
This silicone compound was adopted by engineers of the Aircraft-Automotive Division of Surface Combustion Corporation, Toledo, Ohio, after it was subjected to severe operational testing.

The interior of a stock ignition unit was sprayed with a fine mist of water. The unit, including lead wire and a spark plug with a 5/16 inch gap, was sealed in a bell jar. Air was evacuated with an aspirator. Corona increased as the air pressure dropped until the unit shorted out at a pressure corresponding to an altitude of 25,000 feet.

The unit was then removed from the jar and thoroughly dried. The electrical connections were coated with a thin film of Dow Corning 4 Compound. Again the unit was sprayed with water and sealed under vacuum. Corona discharge was practically eliminated. Even at a pressure equivalent to an altitude of 40,000 feet, there was no sign of failure.

In addition to its usefulness as an auxiliary dielectric, Janitrol engineers report that Dow Corning 4 Compound inhibits corrosion, lubricates ignition cable for easy assembly, and lengthens grommet service life by reducing high temperature oxidation.

No. 49

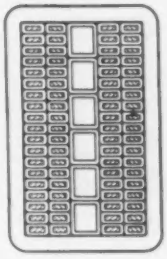


Silastic Caps Used as Dielectric Barriers on High-Voltage "Inner-Cooled" Generator Coils

Engineers at Westinghouse Electric Corporation have greatly increased the capacity of large hydrogen-cooled generators by providing for internal as well as external cooling of the stator coils.

This is done by placing a row of open-ended ventilating tubes inside each stator coil. These metal tubes with conventional insulation are placed between the two groups of transposed conductor strands as shown in the cross-sectional diagram, Figure 1. Differential pressure between one end of the stator winding and the other, forces high density hydrogen through the tubes in close contact with the source of generated heat.

FIG. 1



But the coil ends, where coil-to-coil connections are made, must be left open to permit the hydrogen to pass through the ventilating tubes. Conventional wrap-around surface insulation used since the first motors and generators were invented cannot be used on the connections.

And that's where Silastic* comes in. The vent tubes and coil-to-coil connections are covered with caps molded of Silastic, the Dow Corning silicone rubber. These caps extend far enough beyond the coil ends to form a dielectric barrier that prevents surface creepage and flashover.

The Silastic caps fit solidly over the insulation tapers on the half-coils, and they are taped together with conventional insulating tape. High dielectric strength and voltage endurance, excellent corona resistance, water repellency and the nontracking characteristics of Silastic, assure long service life and complete reliability.

And that is typical of the steadily increasing market for Silastic as a rubbery material with a new order of stability to time and weather and with a new order of usefulness among dielectric materials. This market is in addition to the wide field of usefulness for Silastic as a material that retains its physical and dielectric properties at temperatures far above and far below the limits of any other kind of rubber.

Here are a few of the properties that make Silastic exceedingly useful even where extreme temperatures are not involved. Under identical test conditions, at 14,000 volts, the corona resistance of Silastic cable is in the range of 12,000 hours compared with 30 minutes for organic cable.

The dielectric fatigue curve for Silastic remains relatively flat on long exposure to

*T. M. REG. U. S. PAT. OFF.

(continued pg. 2)

DOW CORNING Silicone News

NEW DEVELOPMENT AND TECHNICAL DATA

For copies of any of the publications reviewed in this column or for data relating to any of the articles printed in this issue of the Dow Corning Silicone News, simply circle the corresponding reference number on the coupon below.

"Silicone Rubber as Electrical Insulation," a reprint of a recent article from ELECTRICAL MANUFACTURING, reviews the properties, advantages and applications of sheet and tape, cable and wire extrusions and other forms of silicone rubber insulating components. *No. 52*

●

Dow Corning Antifoam A, recognized as a most effective defoamer for a wide variety of aqueous and nonaqueous systems, is now available from laboratory supply houses in convenient spray bomb dispensers. Combined with a volatile Freon propellent, Antifoam A Spray quickly and economically controls foams in many batch processes. *No. 53*

●

The Reference Guide to Dow Corning Silicone Products briefly describes the properties and applications of all the most commonly used silicone products. Many manufacturing plants have requested copies for distribution to each of their design and materials engineers. *No. 54*

●

MAY 17-20, 1954 • CHICAGO
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See DOW CORNING SILICONES in action

Visit Booth 329

●

We have recently revised our listing of the manufacturers of silicone (Class H) insulating components. Designers and builders of electric machines and electronic equipment may want to refer to these Sources of Supply. *No. 55*

●

Dow Corning 20 Compound and 20 Emulsion are effectively used as release agents for epoxy, melamine, methacrylate, phenolic, and polyester resin moldings. Their properties and methods of application are described in a recently published data sheet. *No. 56*

DOW CORNING CORPORATION - Dept. RI-17
Midland, Michigan

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NAME _____

TITLE _____

COMPANY _____

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At 160-180 C, Life Expectancy of Test Motors Wound with Dow Corning Enameled Wire Equals Class A at 90 C

Accelerated life testing indicates that 7-1/2 hp induction motors insulated with Class H components and wound with wire coated with Dow Corning Wire Enamel have a life expectancy at 160 to 180 C comparable to that of identical Class A motors with organic enameled wire at 90 C.

As reported in a Conference Paper* presented at the 1954 Winter Meeting of the AIEE, test motors were run to destruction by cycling through heat and moisture. By frequent reversal of the direction of rotation, the several Class A motors were subjected to severe vibration and made to operate at test temperatures of 150, 175 and 200 C.

In the same way, motors wound with wire insulated with Dow Corning Wire Enamel were operated at average copper temperatures of 200, 225, 250 and 275 C. After each heat run, the motor stators were exposed to 100% relative humidity for 24 hours. The test motors were then placed directly on the line at no load for a dryout period before starting the next heat run. The failure points and a band showing the life expectancy of these two classes of motors at various operating temperatures are shown in Figure 2.

One of the motors insulated with Class H materials and wound with wire coated with Dow Corning Wire Enamel is still operating after 53 test cycles including 4769 hours at 200 C.

Results to date indicate that design engineers can use wire insulated with Dow Corning Wire Enamel to increase the life of motors and solenoids that now give inadequate service. This new class of magnet wire will also find a large area of usefulness in reducing the size and weight of electric machines and electronic equipment.

Magnet wire insulated with Dow Corning Wire Enamel is now available from most of the leading wire and cable companies. **No. 50*

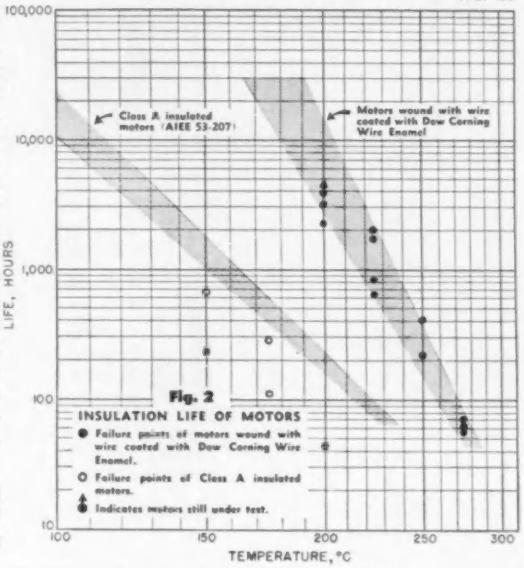

Fig. 2
INSULATION LIFE OF MOTORS
● Failure points of motors wound with wire coated with Dow Corning Wire Enamel.
○ Failure points of Class A insulated motors.
↓ Indicates motors still under test.

SILASTIC CAPS USED *(continued)*

high voltage stress. And dielectric strength and dielectric constant show relatively little change with frequency over a range of 60 cycles to 1 megacycle.

Thermal conductivity is so high that coils can be designed with Silastic insulation to carry the same load and operate at a temperature as much as 30% below that of comparable, resinous insulated coils.

These are some of the properties that make Silastic unique among rubbery materials even at normal operating temperatures. And Silastic is the only kind of rubbery material that is serviceable at temperatures from —100 to above 500 F. *No. 51*

First in Silicones

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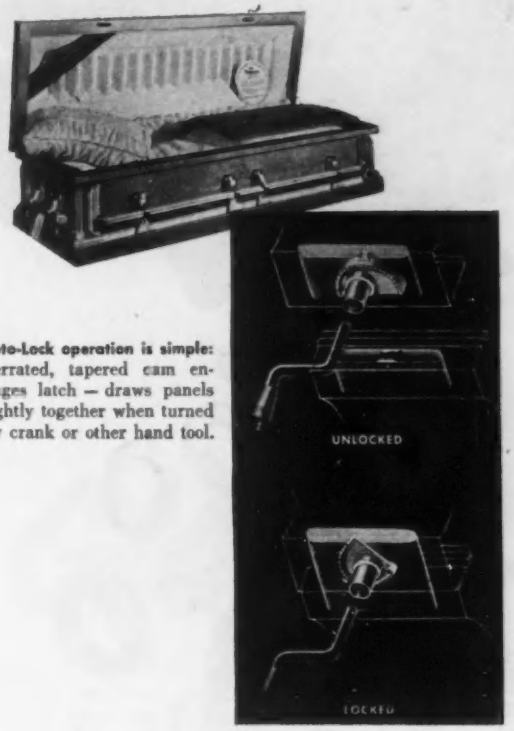
Silicone Electrical Insulating Resins
Silicone Molding Compounds
Silicone Expansible Resins
Silicone Defoamers
Silastic

"Nothing can go wrong with Roto-Lock performance"

Says Elgin Metal Casket Company



Roto-Lock operation is simple: Serrated, tapered cam engages latch — draws panels tightly together when turned by crank or other hand tool.

Simmons Roto-Lock Fasteners are used by Elgin Metal Casket Co., of Elgin, Illinois, to give its Permaseal Caskets a perfect hermetic seal against air and water. Drawn down with a pressure of up to 1500 lbs., Roto-Lock guarantees an absolutely tight seal and strength far beyond requirements.

President E. B. Stewart of Elgin says: "Roto-Lock worked out particularly well because of the simplicity of its construction, and the fact that it was a lock already in a housing which could readily be sealed. Functionally the lock is very good since it pulls the lid down with ease and is a quick-operating mechanism. In other words, *the locking and sealing operation can be accomplished quickly and easily in a matter of seconds.* Since the whole locking and sealing mechanism contains only one moving part, *there is nothing that can go wrong with the performance of the lock.* Of course, this is important since mal-function at a funeral service would be a serious matter."

and there's a Roto-Lock application to improve your product

Roto-Lock, which makes butt or right-angle joints quickly, is finding wide application in portable shelters, air freight and cold storage shipping containers, walk-in coolers, demountable furniture and scaffolding. It fastens in any misaligned or semi-open position and recesses completely into panels. *Wherever* demountability is important, there's a Roto-Lock application.

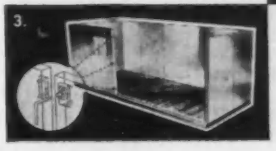
Write today for our 36-page catalog. It's filled with applications of Roto-Lock and Simmons' four other special fasteners engineered to improve products and reduce assembly costs.

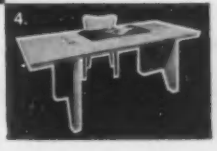
SIMMONS FASTENER CORPORATION
1751 N. Broadway, Albany 1, New York

Simmons

QUICK-LOCK · SPRING-LOCK · ROTO-LOCK · LINK-LOCK · DUAL-LOCK

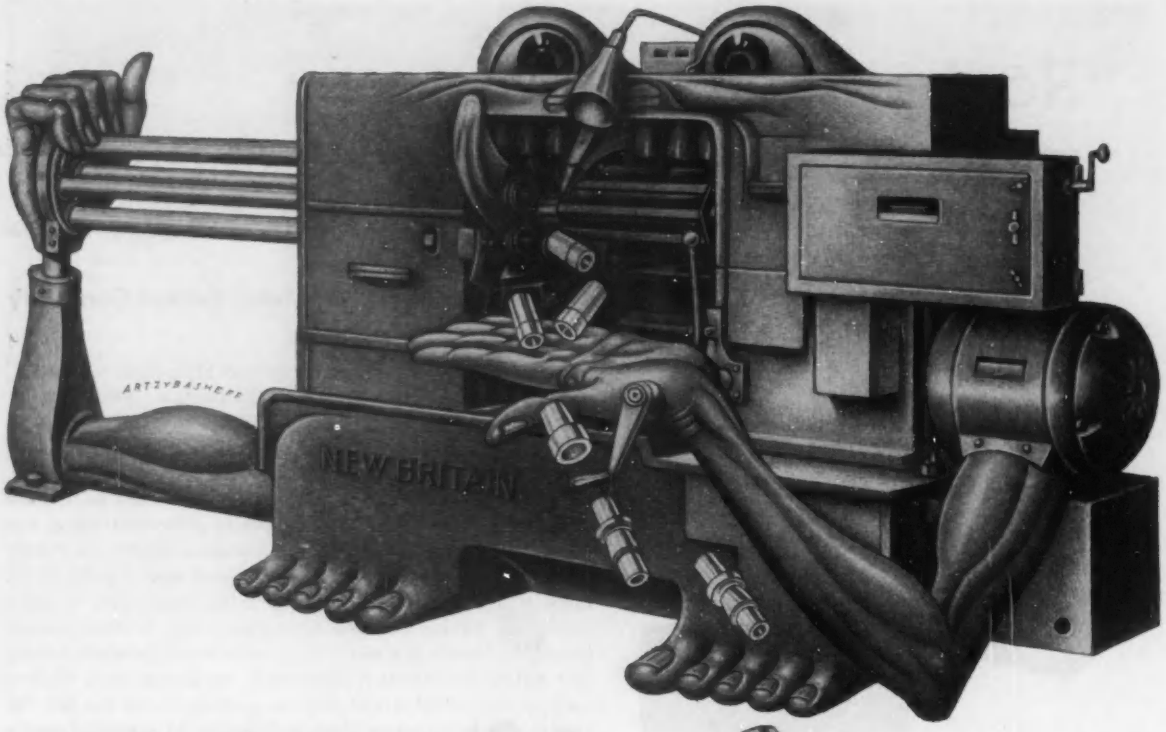
FASTENERS WITH USES UNLIMITED





Some applications of Roto-Lock:

1. Portable Shelter
2. Partition
3. Demountable Refrigerator Unit
4. Demountable Desk



Look what you can do with Alcoa® Aluminum on your New Britain automatic screw machines

Carriers on New Britain automatic screw machines lift automatically during index to eliminate all wear on locating surfaces. Forming slides, mounted on large-diameter, hardened cylindrical studs preserve initial accuracy and permit fast forming advances.

With Alcoa Aluminum Screw Machine Stock, you can operate your New Britains at top feeds and speeds and get fine surface finishes with consistently uniform tolerances. You can lower your piece costs as much as one-third. You get three times as many parts from a pound of aluminum as from a pound of the heavier metals. Aluminum takes all finishes—resists corrosion—conducts electricity and heat exceptionally well.

Find out how aluminum can help you. Contact your local Alcoa sales engineer whose office is listed under "Aluminum" in the classified section of your telephone directory. Or write ALUMINUM COMPANY OF AMERICA, 853-E Alcoa Building, Pittsburgh 19, Pa.

PRODUCTION AND DESIGN ENGINEERS will want two Alcoa booklets, *Alcoa Aluminum in Automatic Screw Machines* and *Corrected Tool Diameter Tables*. Also available at no extra cost are two precision computers —a Speed-Feed calculator, and an alloy property guide which shows at a glance the various properties of Alcoa Aluminum Screw Machine Stock.

ALCOA ON TV brings the world to your armchair with "SEE IT NOW" featuring Edward R. Murrow, Tuesday evenings on most CBS-TV stations.

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

MINIATURE IN SIZE...

GIANT in performance

The dial of this Gotham "Miniature" Mercury Dial Thermometer is only 2½" in diameter, but everything else about it is large-scale. Built for those applications where panel and mounting space are at a premium, it gives you all the accuracy, sensitivity and durability you could ask for.

The entire thermal system is stainless steel with a bulb only half the size of a standard bulb. This small bulb length now enables you to obtain the ruggedness and reliability of mercury actuation in places where only non-mercury actuated thermometers could be used before.

A linear dial—with uniform graduations over a 270° arc—permits precise temperature readings at a glance.

If your application requires a remote reading, quality dial thermometer with hairline sensitivity, constant accuracy and dependability mounted in a small space, the Gotham "Miniature" is your answer. It's designed to give top performance under the most severe operating conditions.

The Gotham line of Mercury Dial Thermometers also includes thermometers in 3½", 4½", 6" and 8½" sizes to suit every type of industrial service. Write today for full information. United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Pa.

FEATURES:

Thermal System	Stainless Steel
Movement	Corrosion-resistant Brass
Dial	Black or white with contrasting figures and graduations
Case	Drawn Steel
Ring	Brass Friction Fit
Mounting	U-shaped clamp assembly
Connection	Center back with ⅛" NPT bulb connection
Ranges	All standard Mercury Dial Thermometer ranges
Accuracy	1% of full scale range over middle half of dial.

Quality Gauges Engineered for Enduring Accuracy

USG UNITED STATES GAUGE

PRODUCTS OF UNITED STATES GAUGE... Absolute Pressure Gauges • Aircraft Instruments • Air Volume Controls • Altitude Gauges Boiler Gauges • Chemical Gauges • Mercury, Gas, and Vapor Dial Thermometers • Glass Tube and Industrial Thermometers • Flow Meters Inspectors' Test Gauges • Precision Laboratory Test Gauges • Marine, Ship and Air-Brake Gauges • Voltmeters • Ammeters • Welding Gauges

OTHER DIVISIONS OF AMERICAN MACHINE AND METALS, INC. AT SELLERSVILLE, PA.: GOTHAM INSTRUMENTS, AND AUTOBAR SYSTEMS

Arthur Marquis
Design and Application Engineer

Arthur R. Kozlowski
Design and Application Engineer

John H. Smedley
Design and Application Engineer

George D. Barcus
Design Engineer

Rollin J. Parker
Supervisor—Magnetic Products Design and Application

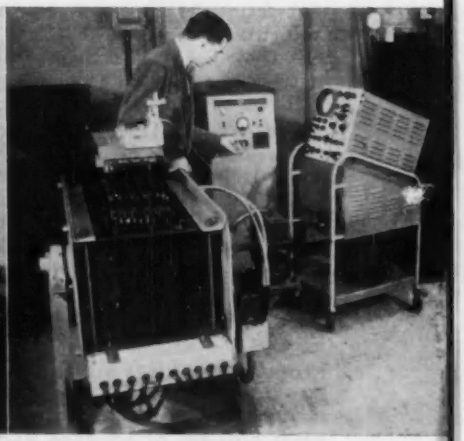
These Carboloy® permanent

At the modern Carboloy magnet laboratory, in Detroit, trained engineers work with the finest equipment. Where necessary, special instruments are often designed by the engineers.

With such complete facilities, Carboloy magnet engineers can give you accurate information, quickly. And, they can thoroughly test their designs and the performance of the magnets in your products.

DC Recording Hysteresigraph. Simultaneously plots magnetic force and resulting magnetic induction. Produces complete hysteresis loops, not ordinary point-by-point readings.

High H-Permeameter. Provides point-by-point readings of magnetizing force and induction. Control table and Ballistic Galvanometer also used for general flux measurements.



Condenser Discharge Magnetizer. Produces very large current impulse for magnetizing magnet configurations that can best be accomplished with special field shapes.

Ernest E. George
Mgr.—Design and Application Engineering

Robert J. Studders
Supervisor—Magnetic Materials and Process Development

Edgar W. Engle
Mgr.—Product and Process Development Engineering

Edgar L. Hubbard
Sales Mgr.—Permanent Magnets

magnet engineers can help you improve products, cut costs

Experienced magnet engineers, using the latest test and development equipment, will provide complete engineering appraisal service

You can get valuable technical assistance, without obligation, on the design and application of permanent magnets, from Carboloy magnet engineers . . . men who are leaders in the field.

Only at the Carboloy Department can you obtain engineering appraisal service and sample magnets from separate laboratory facilities devoted exclusively to helping you determine the design and optimum size, shape and strength magnets to fit your particular application. Your product will be tested in the modern Carboloy magnet laboratories, on the latest test instruments, to assure the maximum operating efficiency of the magnets.

PROVED RESULTS

The assistance Carboloy engineers have given other designers and manufacturers has paid off time and again in lower production costs, improved product efficiency, simplified assemblies and reduced product size.

You can rely on their solutions because these engineers, many of whom worked on the original development of Alnico, are specially trained and experienced in all phases of permanent magnet design and application.

You can depend on Carboloy magnet sales engineers, too, for authoritative and intelligent answers to your questions. These men have intensive, special training in permanent magnets, supporting their engineering and technical backgrounds.

A COMPLETE SERVICE

Together with the engineers who are working on the development of new magnetic materials and on the improvement of existing Alnico grades, *these men make a complete permanent magnet team.* Their sole job is to help you utilize the tremendous potential of permanent magnets for new and improved products.

This team can start working for you, today. Just fill out the coupon and attach to it your company letterhead, and where possible, blueprints or sketches of the job. Or, if you prefer, the coupon will bring a call by your local Carboloy magnet sales engineer.

Three typical, successful appraisal projects:

INSTRUMENTS. Working with Thomas A. Edison, Inc., Carboloy engineers provided the magnet design that made possible a revolutionary fire detection relay. Use of the proper magnets simplified the design of the relay and reduced its size and weight.

CONTROLS. The development of the hysteresis brake was pioneered by Carboloy magnet engineers. Now widely used in the textile and wire rope industries, this brake eliminates friction, while maintaining the necessary constant tension.

TELEVISION. Carboloy magnet engineers collaborated with tube engineers on the design of a new magnetic internal focusing device. They designed the smaller, more efficient magnets that helped eliminate focusing dials and external assemblies.

CARBOLOY
DEPARTMENT OF GENERAL ELECTRIC COMPANY

"Carboloy" is the trademark for products of the Carboloy Department of General Electric Company

CARBOLOY
Department of General Electric Company
11127 E. 8 Mile Blvd., Detroit 32, Michigan

☐ I would like magnet engineering assistance; I am enclosing necessary information and blueprints.

☐ Have a Carboloy magnet salesman call.

Name_____ Position_____

Company_____

Address_____

City_____ Zone____ State_____

Relief... for a production pain

Got an "ache" in your designs? Costs too high . . . production too low . . . product not competitive in price or performance?

For effective relief of production "pains," here's a suggestion. Take advantage of the practical, cost-saving application services offered by your Chain Belt District Engineer, and the outstanding performance of Chain Belt Products.

for example: A lift truck manufacturer was troubled by chain breakage and high over-all cost. His Chain Belt Man recommended a change to leaf chains which not only solved the breakage problem, but actually cut costs.

for example: A construction machinery manufacturer was experiencing considerable trouble due to premature failure of drive chains. His Chain Belt Man solved the problem with Rex Chabelco® Steel Chains designed to withstand the severe operating conditions.

for example: A manufacturer of packaging machines wanted an improved method of handling units through his machines. His Chain Belt Man recommended TableTop® Chain, a chain that provided a smooth, steady, tip-free conveyor, as level as a metal belt.

If your design "pains" involve driving, timing or conveying, your Chain Belt District Engineer can help you. From the complete Chain Belt Line of chains, sprockets, attachments and roller bearings, he can recommend the one best choice for your needs. Try him. Chain Belt Company, 4715 W. Greenfield Ave., Milwaukee 1, Wis.

CHAIN BELT COMPANY

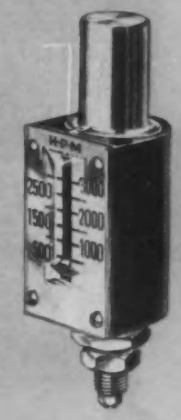
District Sales Offices in all Principal Cities

HYDRAULIC HPM POWER DIVISION

ACCESSORIES

AIR and HYDRAULIC

for every need



● **A COMPLETE LINE** — filters, gauges, pressure switches, weld-type flanges, heat exchangers, slip joints and other equipment—everything you need to round out that circuit.

● **ONE SOURCE FOR HYDRAULIC CIRCUIT REQUIREMENTS**—makes circuit planning, specifying and purchasing easier . . . assures undivided responsibility to user.

WRITE FOR CATALOG TODAY!

Ask For H-P-M's New Accessory Catalog #901

HYDRAULIC HPM POWER DIVISION

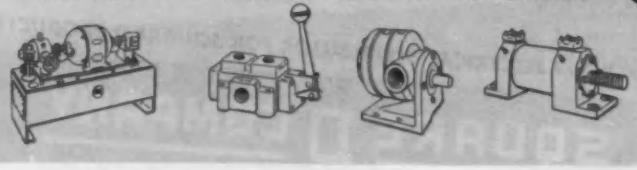
THE HYDRAULIC PRESS MFG. CO.

MOUNT GILEAD, OHIO, U. S. A.

2002 MARION ROAD

A Factor in the Field of Hydraulics Since 1877!

POWER UNITS VALVES PUMPS & MOTORS CYLINDERS



ONE SOURCE FOR ALL COMPONENTS!

Square D OIL-TIGHT NOW FEATURE

FOR **Easier Wiring**

"Slide & Swing" for easier wiring. Hinge pins can be quickly slipped out to remove cover when installing units.

- Assembly of contact blocks directly to operators eliminates alignment problems and assures proper contact overtravel under all conditions.
- Ample wiring space.
- Gasket-sealed mounting holes meet JIC and NMTBA standards.
- Generous size bosses for conduit entry at convenient locations.
- Oil-tight construction guards contacts and wiring from dust and coolant.

more **DESIGN LEADERSHIP** features

- All sizes (1 to 16 units) designed specifically for machine tool service, to JIC and NMTBA specifications.
- Designed to "take it." All-metal buttons. Labyrinth oil seals without diaphragms. Proved oil-tight and coolant-tight by severe tests involving millions of operations. Melamine insulation is non-carbon tracking.
- Attractive appearance. Cast enclosures finished in smooth, baked enamel. Operators have new lustrous plated finish with durable protective coating.

New key-operated selector switch.

ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS

SQUARE D COMPANY

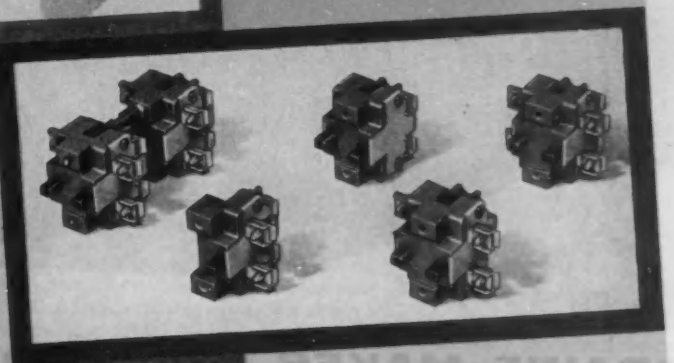
PUSHBUTTON STATIONS
"Slide & Swing" HINGE COVERS

SQUARE D provides more combinations and functions with less stocking than any other pushbutton line!

Any operator combines with any contact block—a virtually unlimited selection of control functions from standard components

operators include *(top row)* locking cover pushbutton, mushroom pushbutton, standard selector switch, key selector switch. *(Bottom row)* lockout pushbutton, coin-operated selector switch, selector pushbutton, standard pushbutton, available in 7 colors.

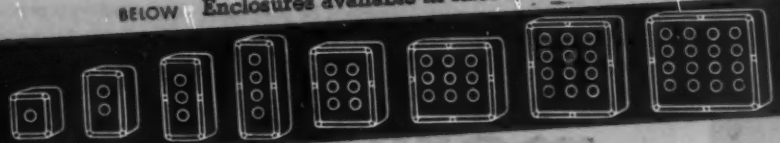
contact blocks include *(top row)* tandem duplex, duplex normally-open, duplex double circuit. *(Bottom row)* single pole double throw, and duplex normally closed. Not shown is three-position duplex block.

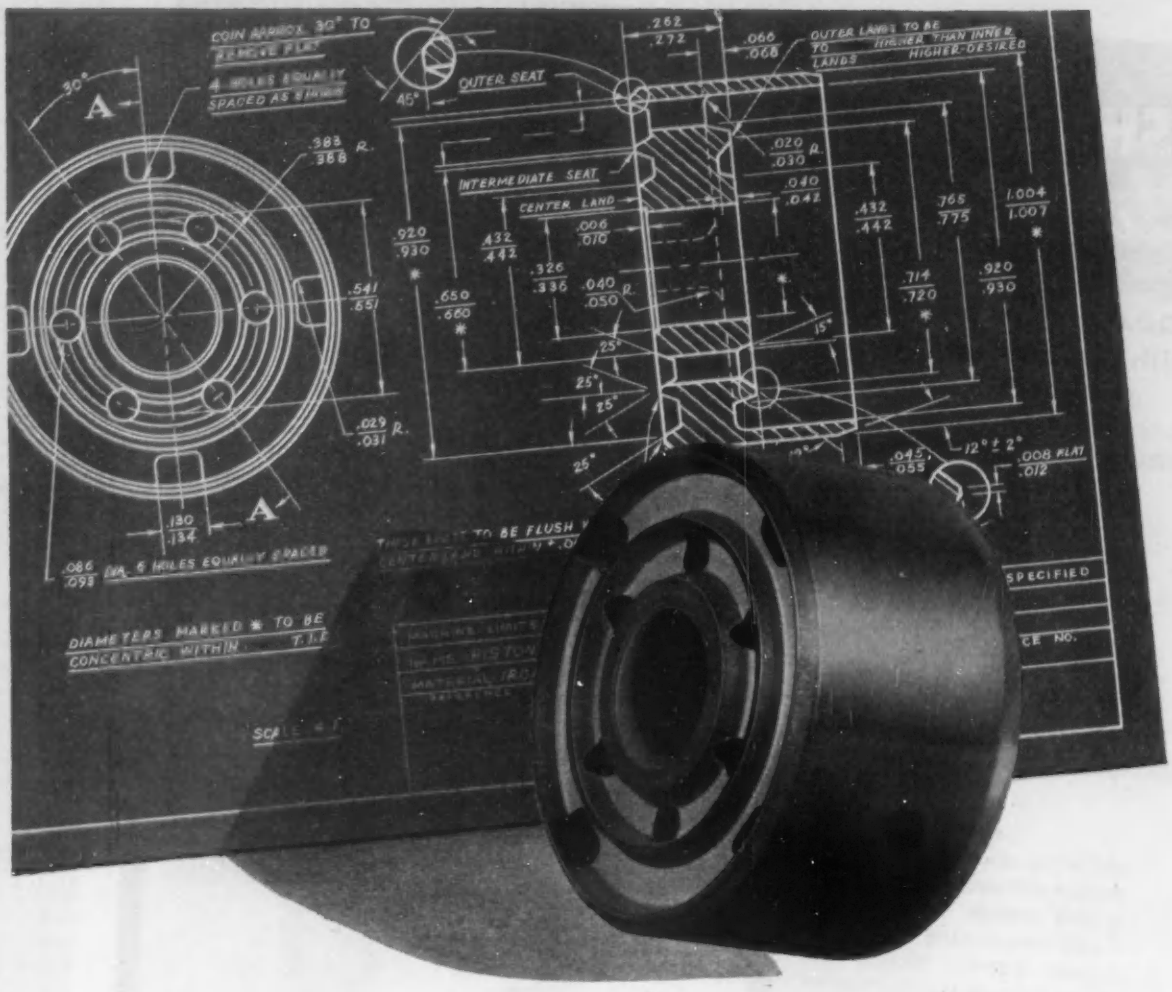


pilot lights in 6 colors. *(Top row)* full voltage type, transformer type, assembly wrench. *(Bottom row)* Nameplates in three standard sizes.

Write for Bulletin 9001 Type T
Address Square D Company
4041 North Richards Street
Milwaukee 12, Wisconsin

BELOW: Enclosures available in sizes from one to 16 units




COIN APPROX. 30° TO REMOVE FLAT
4 HOLES EQUALLY SPACED AS SHOWN
OUTER SEAT
INTERMEDIATE SEAT
CENTER LAND
OUTER LANDS TO BE LOWER THAN INNER
TO HIGHER THAN INNER
LANDS HIGHER DESIRED
.086 .098 DIA. 6 HOLES EQUALLY SPACED
DIAMETERS MARKED * TO BE CONCENTRIC WITHIN T.I.R.
SCALE

MORAINE MAKES MANY COMPLEX PARTS IN ONE OPERATION

A design can be so complex that the cost of making it by conventional casting and machining methods would be prohibitive. Yet, that same design can be produced by the Moraine metal powder process at moderate cost—usually in one press operation —with no drop-off in quality or precision.

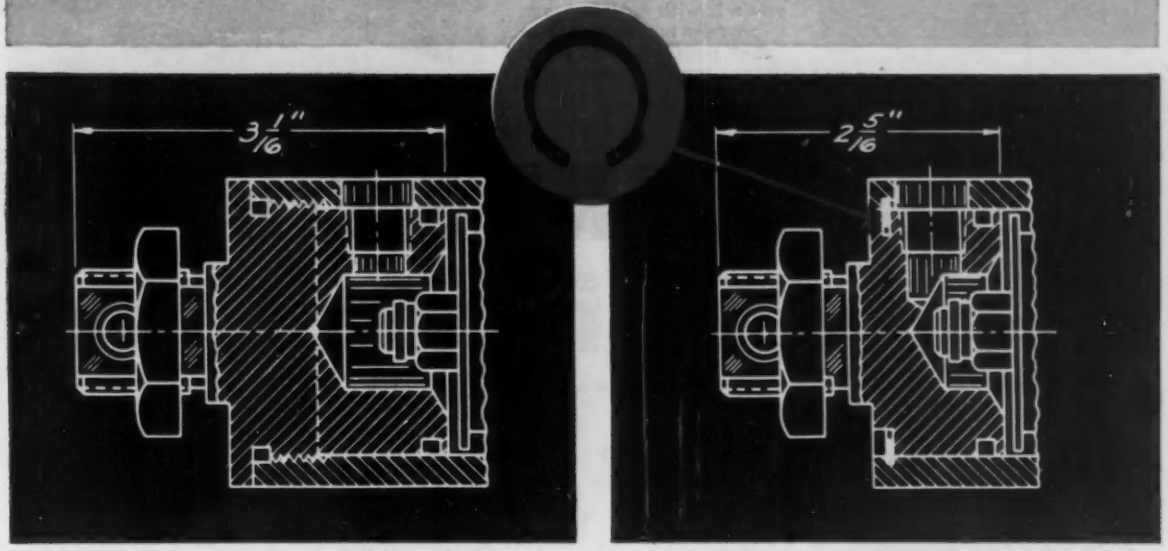
For example, this part, of intricate design and close tolerances, is made in quantity every day at Moraine with very noticeable savings to the customer. It illustrates how much can be done to improve performance and cut costs when customer and Moraine cooperate to adapt part to process.

Moraine's experience with powder metallurgy is extensive and the possibilities it offers to modern industry are almost limitless. There are very few design ideas that cannot be profitably converted into practical parts by the Moraine metal powder process.

moraine products
DIVISION OF GENERAL MOTORS CORPORATION, DAYTON, OHIO

METAL POWDER PARTS

Waldes Truarc Rings Cut Costs $3.26 per Unit, Reduce Size and Weight of Air Cylinder!



OLD STYLE air cylinder, with thread-secured head, required costly tapping, chasing and assembly operations. Also, satisfactory maintenance of packing unit necessitated use of pipe wrenches on painted surfaces.

NEW cylinder head is secured with precision-ground Waldes Truarc Rings. This produces perfect alignment of head within the housing, difficult to obtain with screw-thread seating. Maintenance is quick and easy.

WALDES TRUARC RINGS PERMITTED THESE SAVINGS

Production Time Cut..17 minutes
Weight Saved.....1¾ lb.
Length Shortened.....1½ inches
Cost Saved.....$3.26 unit

■ The A. K. Allen Company of Brooklyn, New York, maker of *AllenAir* cylinders, now uses two Waldes Truarc Inverted Rings (series 5008) to secure heads rigidly within tubes.

■ TRUARC Rings, in this application, are ground parallel by A. K. Allen to .001 tolerance. In a static hydraulic bursting test, the 3" unit (recommended for 350 p.s.i.) withstands a pressure of 2000 p.s.i. And at bursting-point, the brass groove gives way; the Truarc Ring remains intact.

■ Waldes Truarc Retaining Rings are precision-engineered . . . quick and easy to assemble and to disassemble. They can be used over and over again. There's a Waldes Truarc Ring to answer every fastening problem.

■ Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers.

For precision internal grooving and undercutting . . . Waldes Truarc Grooving Tool

SEND FOR NEW CATALOG ➧

WALDES
TRUARC
REG. U. S. PAT. OFF.
RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,428,341; 2,439,765; 2,441,846; 2,455,163; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,091; AND OTHER PATENTS PENDING.

PN056

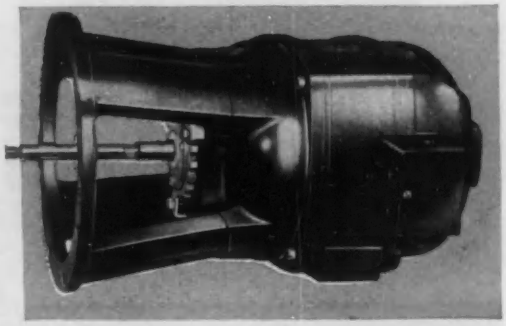
Waldes Kohinoor, Inc., 47-16 Austel Pl., L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print)

Name.....
Title.....
Company.....
Business Address.....
City..... *Zone*..... *State*.....

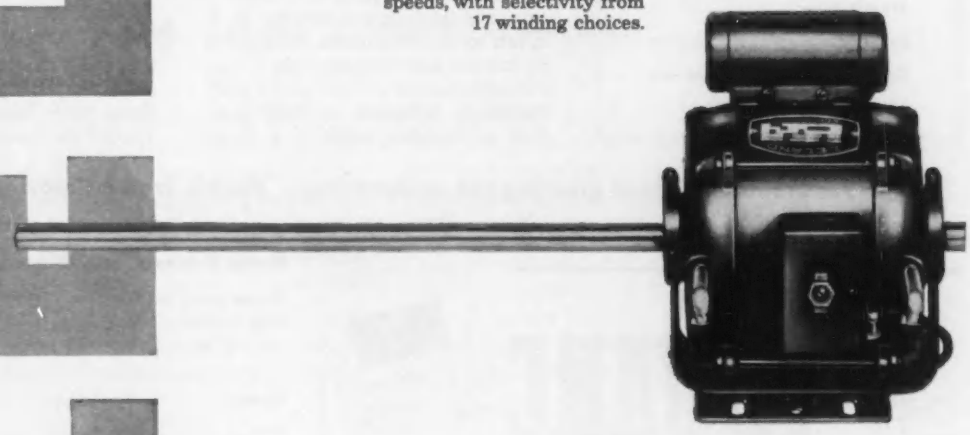
LELAND

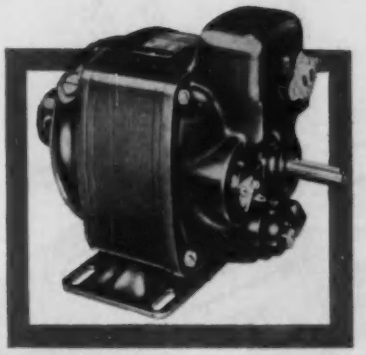


Unique Leland motor, designed to mate precisely with vacuum pump, provides micrometer axial shaft positioning and pump impellor adjustment.

LELAND'S Creative is more than

Year-round "thermal conditioning" in an unusual ventilating unit is quiet and comfortable, thanks to the enclosed, efficient Leland motor power. Special extended blower shafts turn at high or low speeds, with selectivity from 17 winding choices.





The Leland-developed explosion-proof motor that for 30 years has outsold all other makes combined for powering gasoline curb pumps.

Electrical Engineering a phrase!

Leland's whole organization is particularly geared to serve the needs of the Original Equipment Manufacturer. When his exact requirements cannot be filled by one of the many *standard* types of Leland motors, Leland engineers *welcome* the opportunity to work closely with his products' engineers to provide the required mechanical or electrical design.

During more than 30 years, Leland's *creative electrical engineering* has produced hundreds of special motor designs . . . each ideally suited to a specific application. These designs, carefully filed for quick reference, now provide ready-made answers to many current application problems, often enabling Leland to fill special motor requirements with maximum speed and economy.

Leland's representatives are graduate engineers, thoroughly qualified to grasp and discuss your motor needs. If these needs fall within the 1/6 to 5 HP range, you'll do well to contact your local Leland representative . . . or write or phone direct to—

Special features of this Leland food machinery motor design include interchangeable mounting for ¾, 1 or 1½ HP, single phase or three phase.

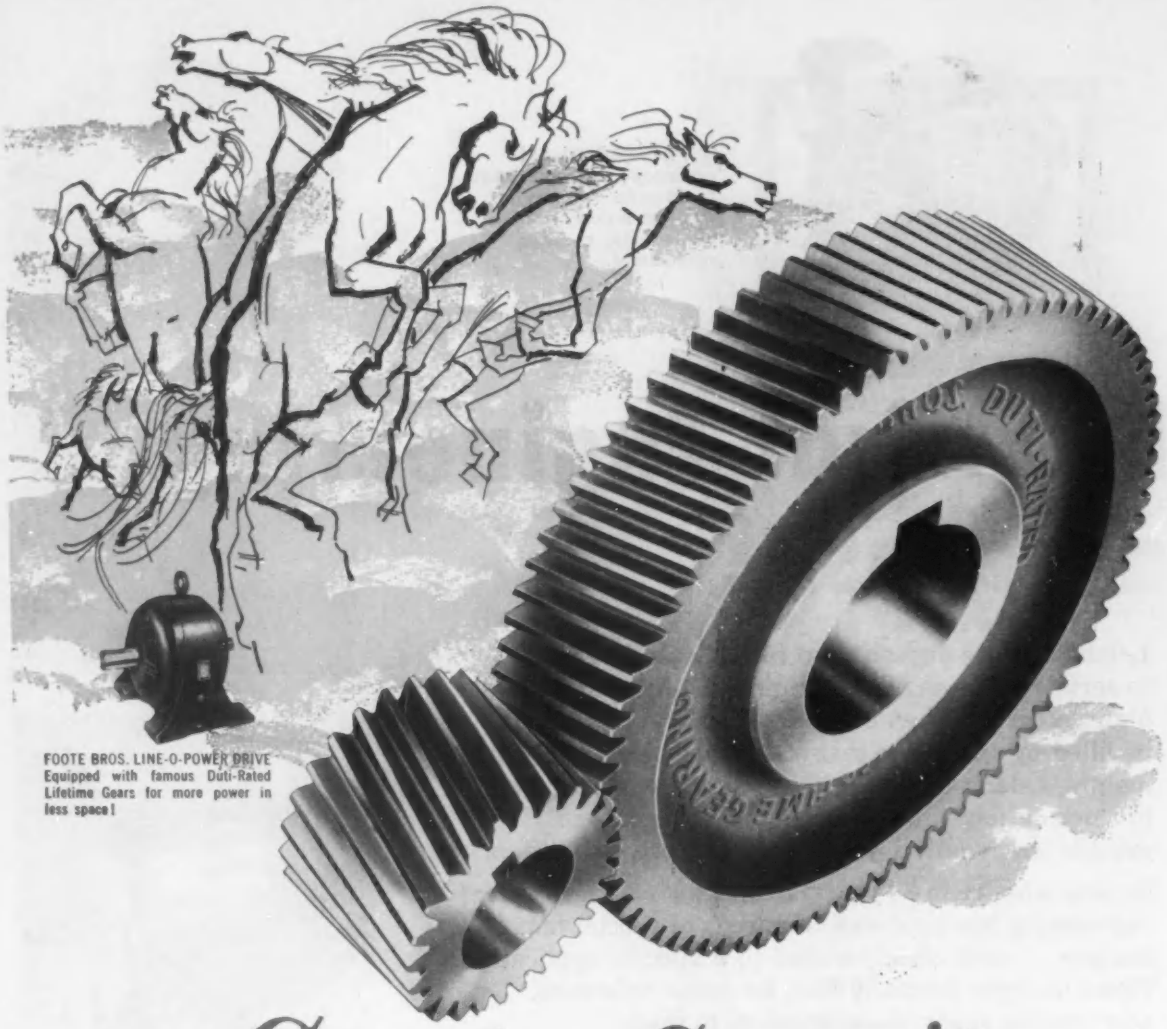
The LELAND ELECTRIC Co.

DAYTON 1, OHIO

Division of AMERICAN MACHINE & FOUNDRY COMPANY, New York

In CANADA, Leland Electric Canada, Ltd., Guelph, Ontario

AMF products are better . . . by design



FOOTE BROS. LINE-O-POWER DRIVE
Equipped with famous Duti-Rated Lifetime Gears for more power in less space!

Greater Capacity

COMES IN A SMALLER PACKAGE

FOOTE BROS. Duti-Rated LIFETIME GEARING

FOOTE BROS.

Better Power Transmission Through Better Gears

Manufacturers of industrial gears and enclosed gear drives of all kinds, gear motors, aircraft-quality gears and actuators and special machinery

WITH FOOTE BROS.

Duti-Rated LIFETIME GEARING

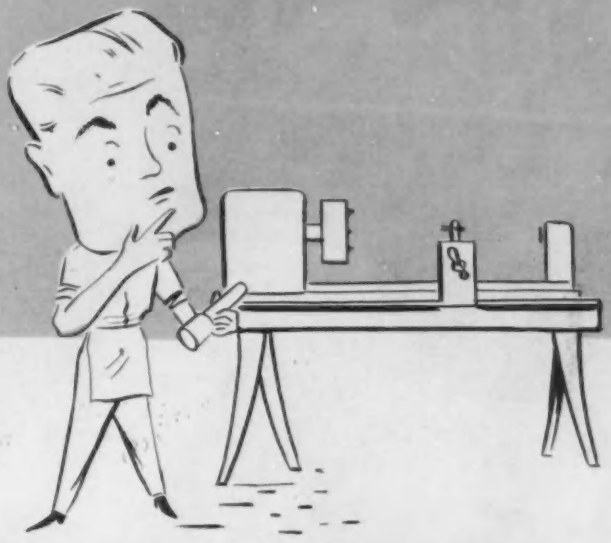
A unique development in industrial gear production . . . new, *Duti-Rated Lifetime Gears* . . . a Foote Bros. exclusive! From its vast experience as a leader in aircraft-quality gear manufacture, Foote Bros. has applied the important characteristics of aircraft gearing to its *industrial* gear production. The results are highest quality gears with greatly reduced mass, longer life and higher capacity than ordinary industrial gears. What's more, Duti-Rated Lifetime Gears can *actually cost less* than other gears of similar capacity! The time to investigate is *now* . . . the gears to specify are *Duti-Rated Lifetime Gears!*

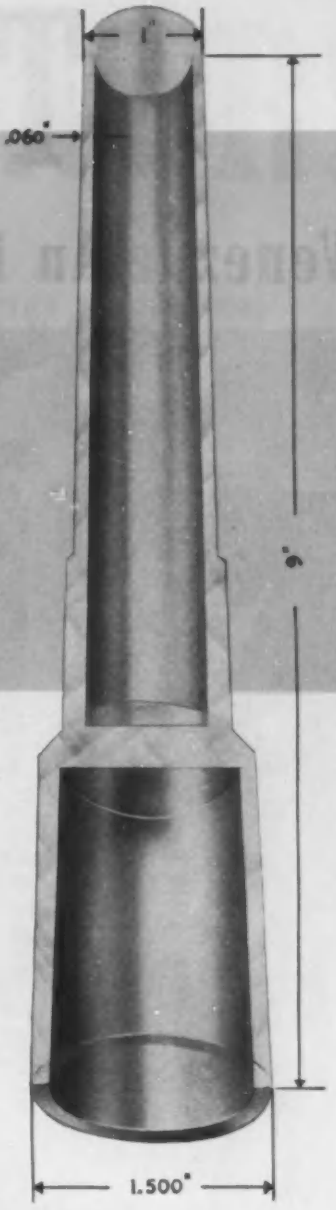
WRITE FOR COMPLETE DETAILS . . . on how Foote Bros. Duti-Rated Gears can fit into your picture. Write *today* . . . for better power transmission *tomorrow!*

FOOTE BROS. GEAR AND MACHINE CORPORATION • 4545 SOUTH WESTERN BOULEVARD • DEPT. W • CHICAGO 9, ILLINOIS

mr. design engineer...

could you machine this part in one piece?





No need to try when you specify...

HUNTER DOUGLAS
IMPACT FORGING
FROM
HIGH STRENGTH ALUMINUM ALLOYS

Possibly this double diameter tube could be machined, but it is being made faster, stronger, and at less cost by the Hunter Douglas cold Impact Forging process. Formerly this tube was fabricated from three parts involving six operations with the resultant problem of leakage when subjected to high pressure. Impact Forging requires a single operation to produce this same tube that withstands a bursting pressure of *5500 p.s.i.* without distortion! The economies in production time are obvious. When you are designing a part with the following characteristics:

Walls of zero draft • *High physical properties* • *Tubular shapes with or without a closed end*
Close dimensional tolerances • *Mass production requirements up to a million or more a month*

REMEMBER THE NAME HUNTER DOUGLAS

We invite you to submit blue prints or sample parts for our engineering department's prompt analysis.

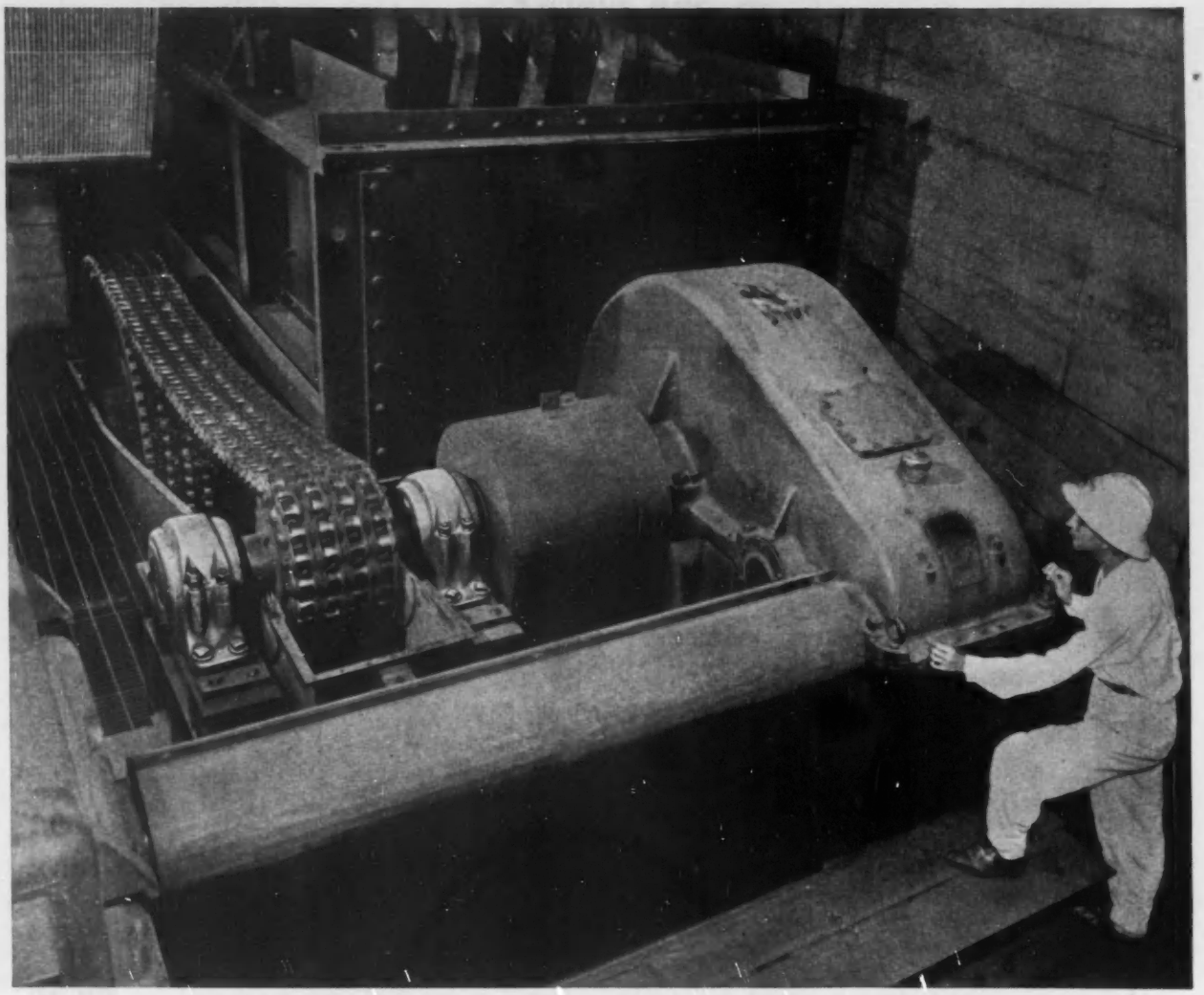
write for free brochure on your company letterhead

HUNTER DOUGLAS *CORPORATION*

DEPT. PE-5 • RIVERSIDE, CALIFORNIA • TELEPHONE RIVERSIDE 7091

TOUGH JOB?

Venezuelan iron ore rolls to the sea on



Roller bearing pillow blocks form part of this pre-integrated drive on the primary crusher at Puerto Ordaz. Other Link-Belt products shown include roller chain and sprockets, and parallel shaft drive, in addition to the massive 7-ft. wide apron feeder, strong enough to receive a direct load of 20 tons.

LINK-BELT

BALL AND ROLLER BEARINGS

LINK-BELT ball and roller bearings keep company with

READY ANSWER!

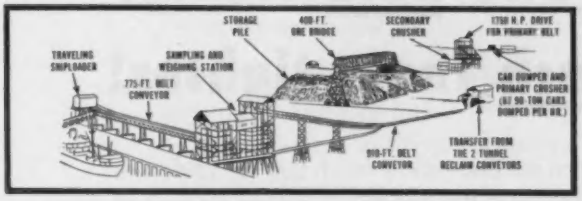
LINK-BELT BEARINGS

AT Puerto Ordaz, 545 miles north of the equator, U.S. Steel's Orinoco Mining Co. moves iron ore from mine car terminal to ocean-going ships via belt conveyors. Designed for a possible future capacity of 12,000 long tons per hour, this is the largest ore-handling system ever built at one time.

Taking the pounding of the heavy ore . . . operating day in and day out in high humidity—Link-Belt bearings are used extensively throughout the project.

You'll find Link-Belt bearings the first choice of a growing number of leading design and consulting engineers. Precision built—with ample capacity for misalignment—these bearings deliver years of high-efficiency service under the toughest operating conditions.

Next time you have a bearing problem, get in touch with your nearest Link-Belt engineer. He'll recommend the bearings that best meet your requirements from this broad, quality line.

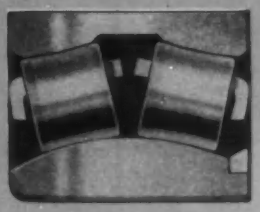

STORAGE PILE
400-FT. ORE BRIDGE
SECONDARY CRUSHER
1750 H.P. DRIVE FOR PRIMARY BELT
TRAVELING STACKER
SAMPLING AND WEIGHING STATION
775-FT. BELT CONVEYOR
CAR DUMPER AND PRIMARY CRUSHER (67 50-TON CARS DUMPED PER HR.)
810-FT. BELT CONVEYOR
TRANSFER FROM THE 2 TUNNEL RECLAIM CONVEYORS

Schematic flow sheet traces the ore's movement. As prime contractor, Link-Belt fulfilled a single-contract responsibility on this huge job on which Link-Belt bearings are important components. With the excellent cooperation of sub-contractors and suppliers, engineering, fabrication and installation were completed in 23 months, five months ahead of schedule.

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,500-DE

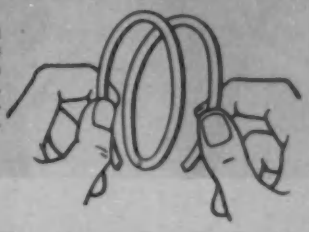
FACTS: for consulting and design engineers

Link-Belt Series LPK-6800-F "Mill Bearings" are the answer for heavy industry. Proven Link-Belt self-aligning roller bearings are housed in steel.

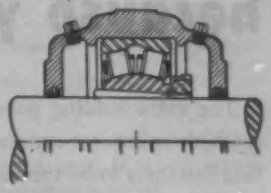


FREE-ROLLING—SELF-ALIGNING—The Link-Belt "Mill Bearing" adjusts immediately in all directions, assuring full load capacity even when subjected to shaft deflections and inaccuracies of mounting. These important features enable the bearings to readily sustain heavy, sudden shock loads.

LUBRICATE WITH EITHER OIL OR GREASE—Spiral Steel seals provide effective retention of either type of lubricant. What's more, housing sealing fully protects all moving surfaces.



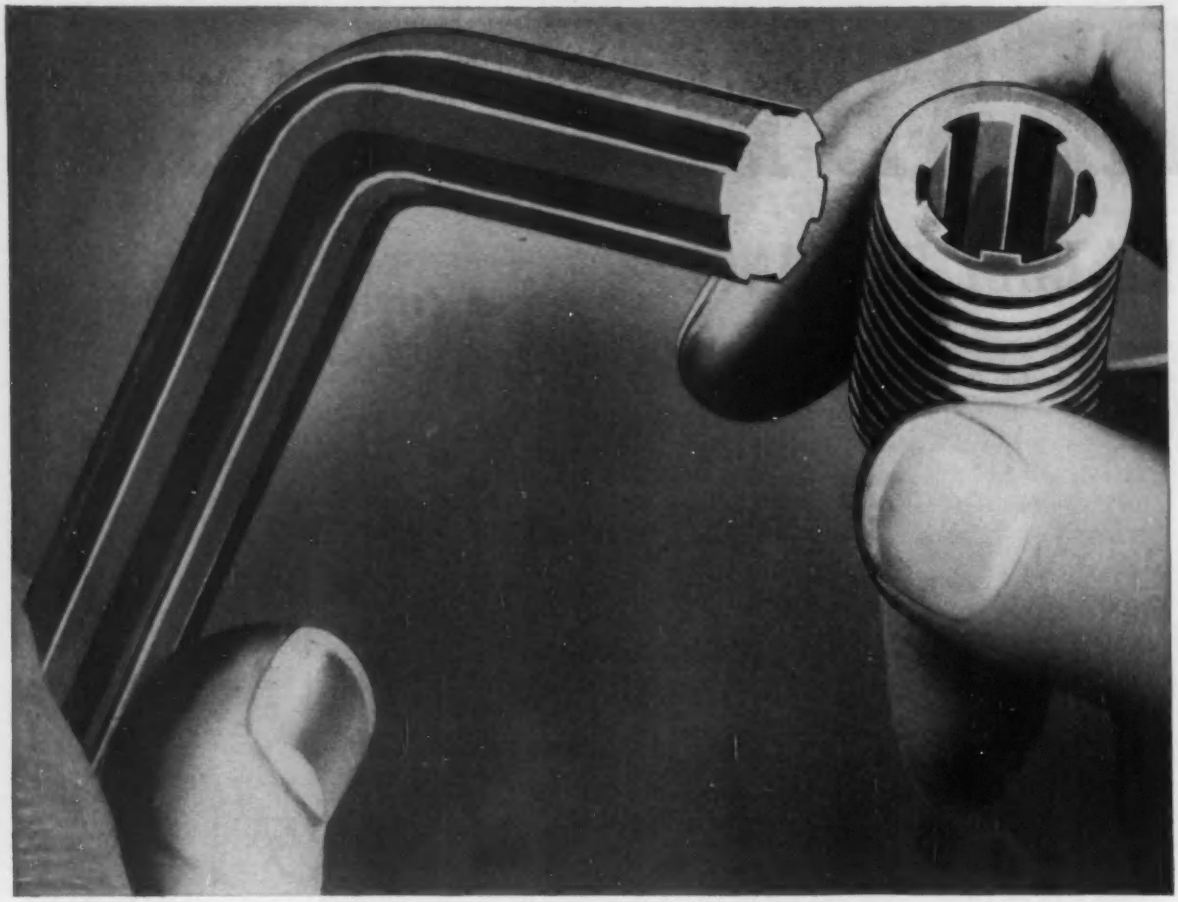
END PLATE can be used for protection where shaft terminates at the bearing. No added machining is necessary.



COMPACTNESS is achieved with self-contained design. There are no external rotating parts to mar smooth appearance.

Series LPK-6800-F "Mill Bearings" are part of Link-Belt's complete line of pillow blocks, flanged, flanged cartridge, cartridge, take-up and hanger blocks and unmounted bearings. Ask for Book 2565. For facts on the entire Link-Belt line, get Book 2550.

America's hardest-working machines



Multiple-Spline Set Screws hold tighter— because you can wrench them tighter!

The extra holding power of Bristol's exclusive multiple-spline set screws enables these flush-fitting fasteners to be used in the newest, most compact design applications.

They withstand severe shock and vibration, permitting fewer and smaller screws to be used without sacrificing strength.

While the splining principle has long been recognized as the best means of transmitting rotary power, the materials of which they are made also contribute to the tremendous holding strength of these Bristol set screws. Standard screws are made of heat-treated alloy steel; bronze, brass, monel or other metals are available on special order.

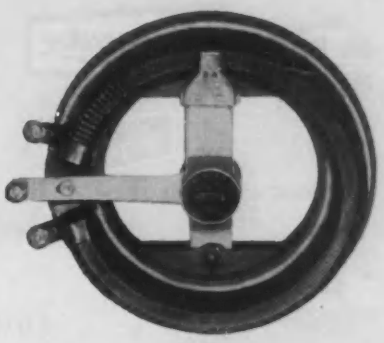
Bristol multiple-spline set or cap screws are carefully designed to close tolerance (ASA approved) in sizes from 0 wire to ½" in diameter. Get them through your regular industrial distributor.

BRISTOL'S SOCKET SCREWS

THE BRISTOL COMPANY, Socket Screw Division, Waterbury 20, Conn.

25 WATTS...

to 500 WATTS...



The Mallory Line of Rheostats is COMPLETE!

The complete Mallory line, including the new 25-watt rheostat, gives you a full range of eight different sizes in a wide range of resistance values.

With Mallory Rheostats, you get the advantage of more precise linearity, because of the extreme accuracy of Mallory's exclusive wire winding technique.

Equally important is the long dependable performance that you can be sure of when you use Mallory. Here is why.

Each Mallory Rheostat is designed for adequate ventilation.

Windings are sealed into position around a high quality ceramic core by a protective coating of porcelain vitreous enamel.

All current carrying parts are insulated by dimensionally stable ceramic parts.

You can meet special requirements with Mallory Rheostats, too. They are available with variable pitch windings for special tapers . . . and in tandem construction. Let us send you a copy of our new catalog covering detailed specifications of the complete line of Mallory Rheostats and Vitreous Enamel Resistors.

The hinged contact arm is another important Mallory feature.

It permits inspection or replacement of the brush without disturbing contact pressure.

Different spring tensions are available to suit the wire size and requirements of each application.

Tension spring carries no current. There is no possibility of annealing during overloads.

A separate spring on the shaft controls shaft torque to your requirements. It is *not* interdependent with the contact arm spring.

Expect more...Get more from MALLORY

Parts distributors in all major cities stock Mallory standard components for your convenience.

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When you build the high capacity and long service life of Torrington Needle Bearings into your products, you will join the manufacturers whose trade-marks are reproduced here—and thousands more—who use Needle Bearings.

Our Engineering Department will be glad to help you determine how Needle Bearings can be used to advantage in your products.

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Torrington, Conn. South Bend 21, Ind.

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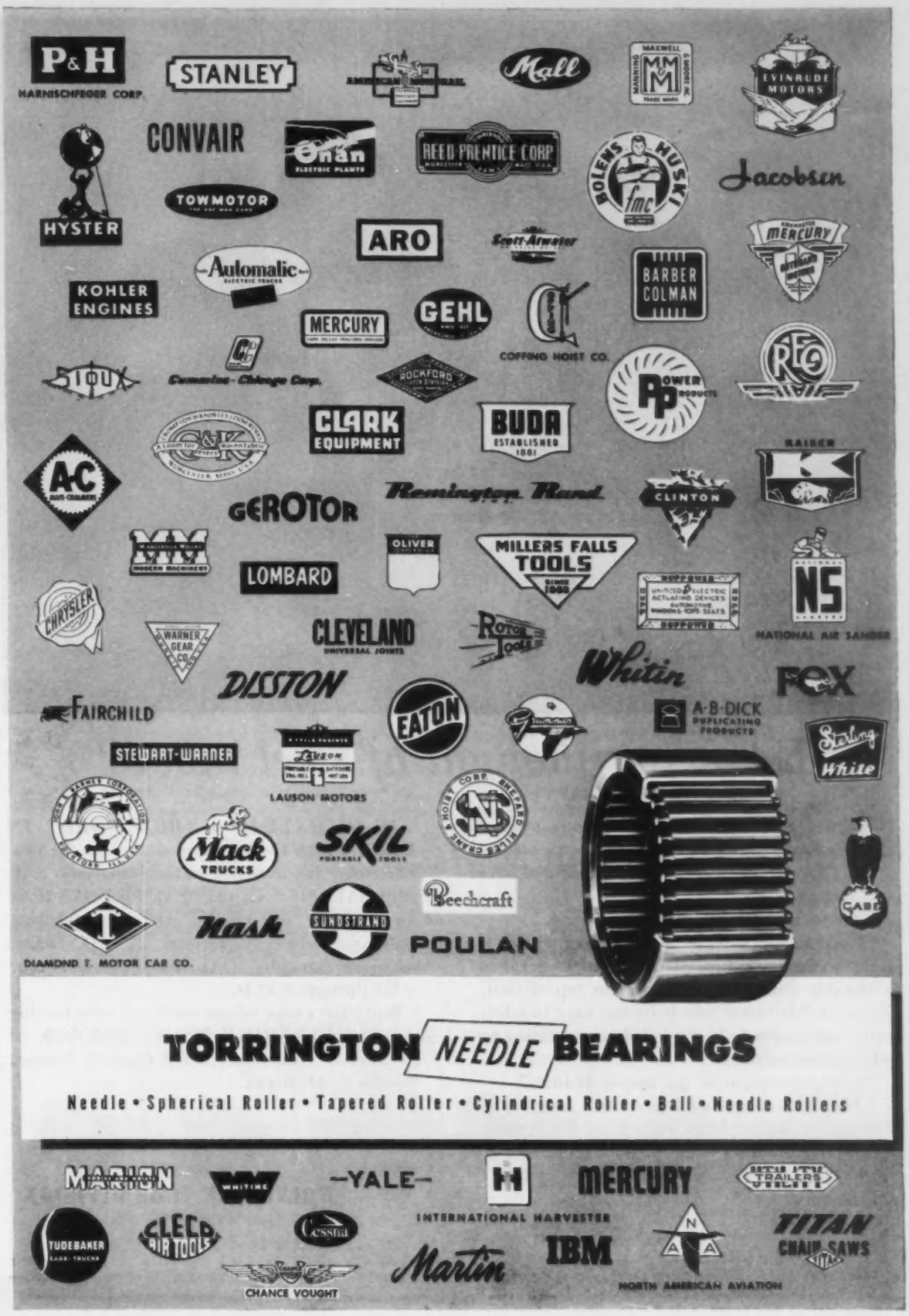
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"Have you thought of steel tube?"

"I've been thinking of the points you mentioned and, frankly, I am sure Wolverine electric-welded steel tube will do everything you want and save you money to boot!"

"That's fine, but what about finishing."

"Look at this sample. You can paint it, or if your operations call for plating, you can get it in a suitable finish for that, too. On top of that, electric-welded steel tube is strong, easy to fabricate, and simple to join by soldering, welding or other fastening methods."

"Steel tube might be the answer at that."

"And Wolverine's quality control program is a standout bonus! Their reputation for making tubing to close tolerances and with uniform wall thicknesses assures you continuing product satisfaction."

IF QUALITY IS A "BUY WORD" IN YOUR PLANT: Wolverine is the tube for you. Remember it's available in these analyses: SAE 1010, SAE 1015, SAE 1020, SAE 1025, SAE 1030. And in these size ranges: condenser and heat exchanger tube—½" through 2" O.D.; boiler tube—½" through 3" O.D.; and mechanical tube —¼" through 3" O.D.

Write for a copy of our new steel tube catalog today! WOLVERINE TUBE DIVISION of Calumet & Hecla, Inc., 1479 Central Avenue, Detroit 9, Michigan.

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Manufacturers of Quality-Controlled Tubing

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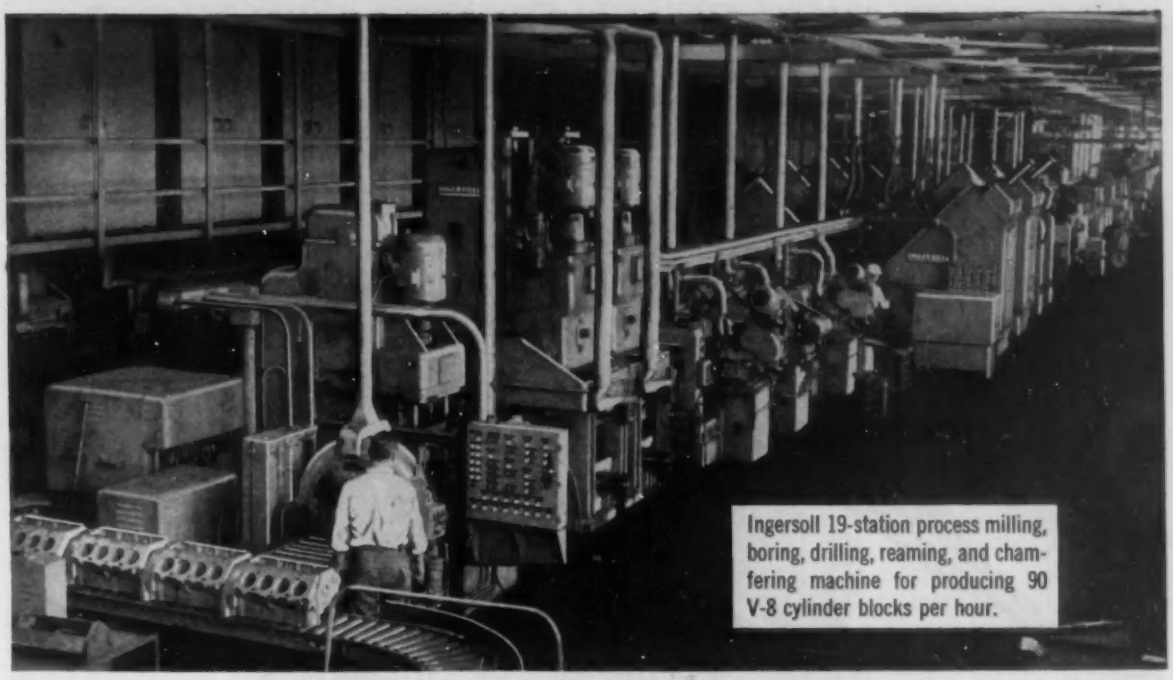

Ingersoll 19-station process milling, boring, drilling, reaming, and chamfering machine for producing 90 V-8 cylinder blocks per hour.

automation at its best uses VICKERS® hydraulics

One operator controls this entire machine in which a total of 20 milling, 18 boring, 16 chamfering and 4 drilling spindles are at work simultaneously. A hydraulic transfer mechanism moves the V-8 engine blocks automatically from station to station . . . turning them as needed . . . clamping and unclamping. Feeding of the tools is also done hydraulically. The entire operation is controlled by electro-hydraulic circuits from the loading station.

Vickers Hydraulics was used throughout by The Ingersoll Milling Machine Company. Among the advantages gained by using Vickers Hydraulics are: (1) simplification of design, (2) flexibility of control, (3) instantaneous response, (4) ease of providing interlocks and overload protection, (5) low maintenance with minimum down time.

The Vickers Application Engineer near you will gladly supply any additional information you may desire regarding the many benefits to be gained by using Vickers Hydraulics.

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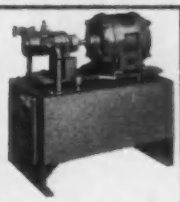
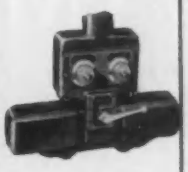


Power Unit is Self-Contained Power Source

Solenoid Controlled Pilot Operated 4-Way Valve



Traverse and Feed Cycle Control Panel

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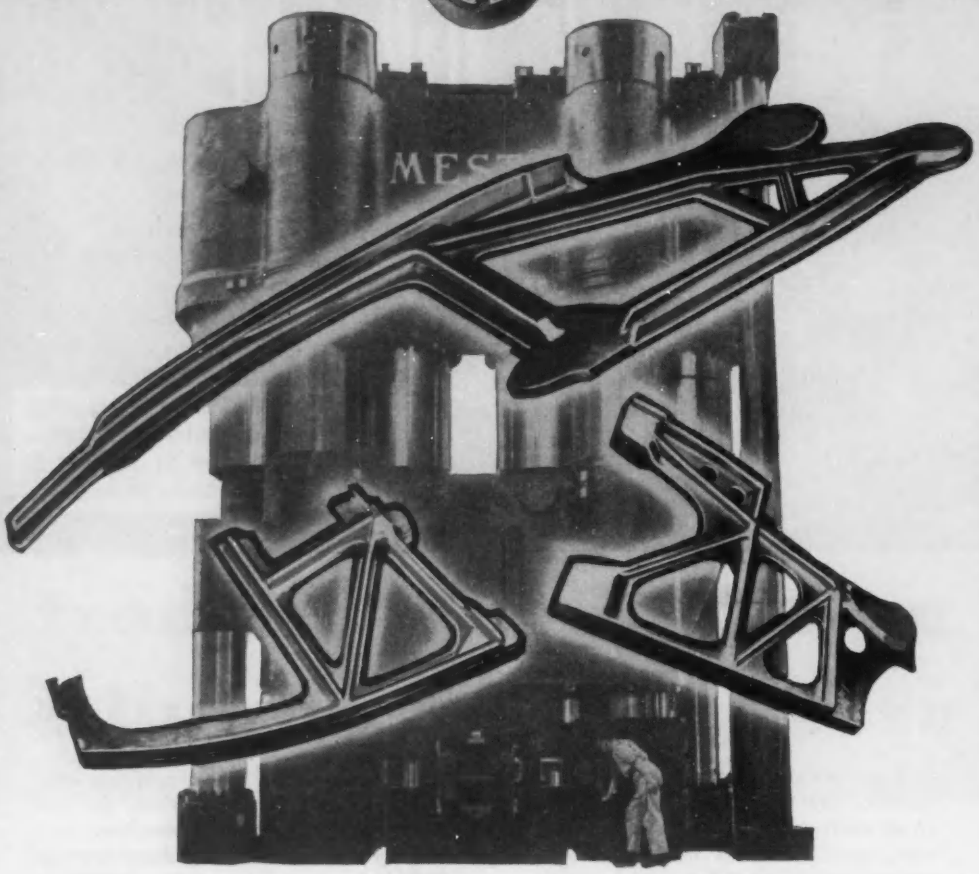
6684

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921



Greater Size and Speed in Aircraft have created engineering problems, the solution of which has required larger and larger forgings of high-strength aluminum alloy. *Examples* shown above are forged structural members used in a modern military bomber, the largest more than seven feet over all. These are forged on an 18,000 ton press, the biggest ever built in this country.

Wyman-Gordon Experience—the most extensive in the industry—is keeping abreast of new forging demands involving the use of Steel, Aluminum, Magnesium, High Density Alloys and Titanium.

• • •

Standard of the Industry for More than Seventy Years

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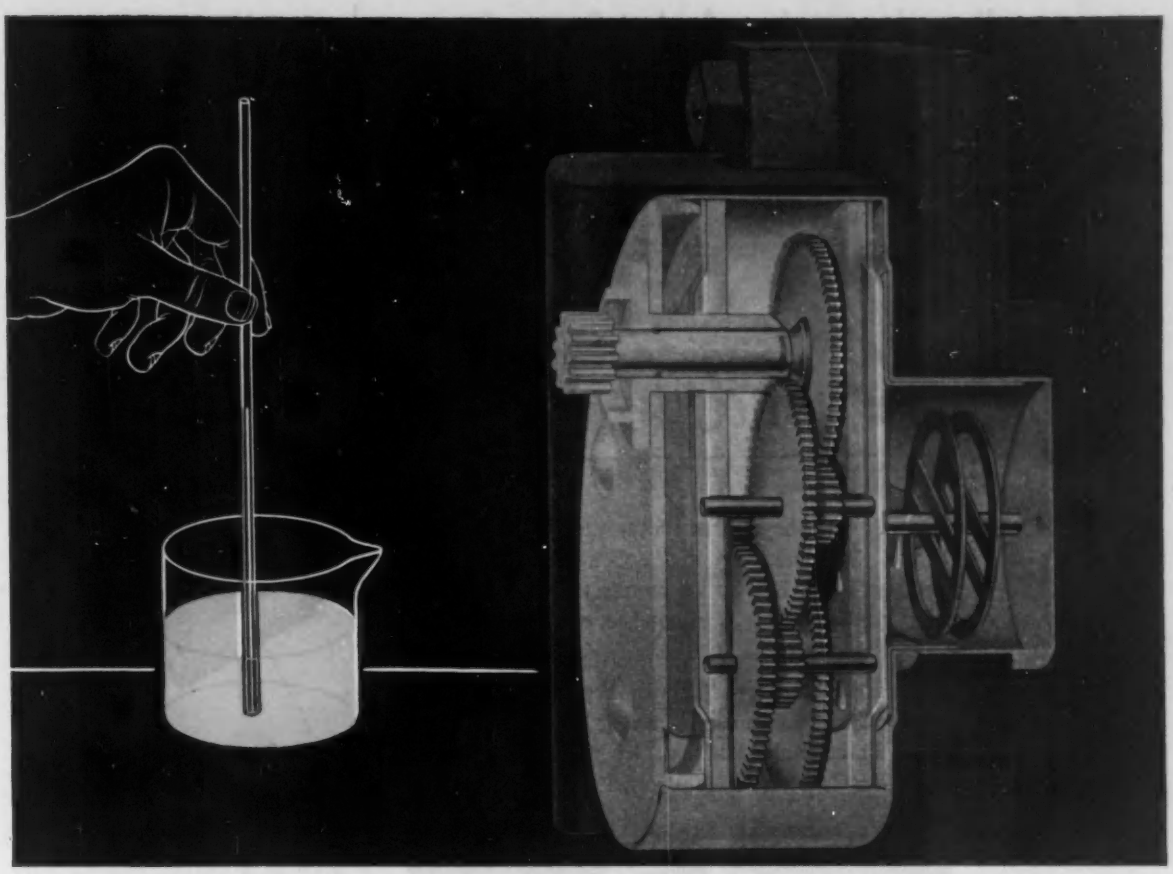
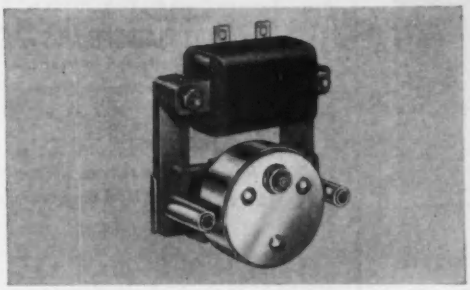


MORE evidence of the extra VALUE in TELECHRON timing motors . . .



Lubrication is only part of the Telechron motor story. Lightweight rotors assure quick starting. Gears are hobbed for quiet operation. Power-line accuracy means true synchronous performance. Separation of the field from the rotor results in cooler operation and longer life.

The accurate, dependable, inexpensive Telechron Synchronous Motor is the heart of timing you see everywhere . . . in clock-radios, washers and dryers; in heating controls, refrigerator defrosters and air conditioners . . . in industrial time switches, recorders and instrumentation.

CAPILLARY ACTION FEEDS OIL TO MOVING PARTS

One secret of the lasting accuracy of a Telechron timing motor is its exclusive sealed-in system of lubrication.

Each Telechron motor carries just the right amount of oil, locked-in against dirt and dust. The oil is drawn up the spaces between bearings and capillary plates by the same free-flowing process that pulls water up the hollow stem of a plant—or a glass tube. Bearings are constantly covered with a thin coating of oil.

This way the oil lasts the life of the motor—which, with a Telechron timing motor, can be for years and years.

Write for complete catalog and full information on our Application Engineering Service. Telechron Department, General Electric Company, 15 Homer Avenue, Ashland, Mass.

Telechron

MARK OF TIMING LEADERSHIP

How do you buy Socket Screws?

Do you specify some one make by *habit*, because you think *all* such fasteners are alike — all simply "screws with hex sockets?" If you do, and have never used P-K Socket Screws, break the habit *once* and give them a trial. You'll find that the hex shaped socket is about the *only* way other makes and P-K are "alike."

Look Beyond the Hex

It pays to look beyond the socket when you buy Socket Screws. Compare every detail of product and service, and you'll find P-K Socket Screws take top honors in every test for quality, performance, economy.

Why miss out on any of the advantages you can get with P-K Socket Screws? Try them. For samples, catalog, or any needed information, see your P-K Distributor, or write: Parker-Kalon Division, General American Transportation Corporation, 200 Varick St., New York 14.

The Only SIZE-MARKED Socket Cap Screws — with Gear Grip. Prevents errors . . . saves time and wasted screws when sizes get mixed up. Helps maintenance and service men in re-assembly. *Maximum Strength* — head, socket, threads accurately formed by P-K's cold-pressure process. Steel structure "flows" to conform to all contours, assures maximum strength at points of greatest stress.

FOR ADVANCED DESIGN that speeds assemblies — makes them simpler, stronger — and saves errors.

FOR TOP QUALITY and tolerance gaged to your most exacting specifications — and guaranteed.

FOR ASSEMBLY STRENGTH okayed in a million punishing tests by thousands of satisfied users.

FOR PLANNING AIDS and buying data patterned to your special needs, plus advice on assembly.

FOR SUPPLY SERVICE set up for fast action and lower purchasing expense — by local Distributors.

GET ALL THESE ESSENTIALS OF COST-WISE ASSEMBLY

PARKER-KALON SOCKET SCREWS

SAY P-K

FULL RANGE of styles and sizes. You'll find any Socket Screw you need in P-K's complete line. Hex Keys in all sizes, and several handy sets.

In Stock for immediate delivery — see your nearby P-K Distributor

Need pins, pivots, mandrels, or other small parts? Need them in fine micro-finishes and tolerances in tenths . . . in special sizes and types to fit your product designs?

Torrington produces a wide variety of parts to customers' exact specifications . . . *faster, better and for less* than you can make them in your own plant. Why not let Torrington apply their many years of experience to *your* problems and have their special automatic machinery work for you?

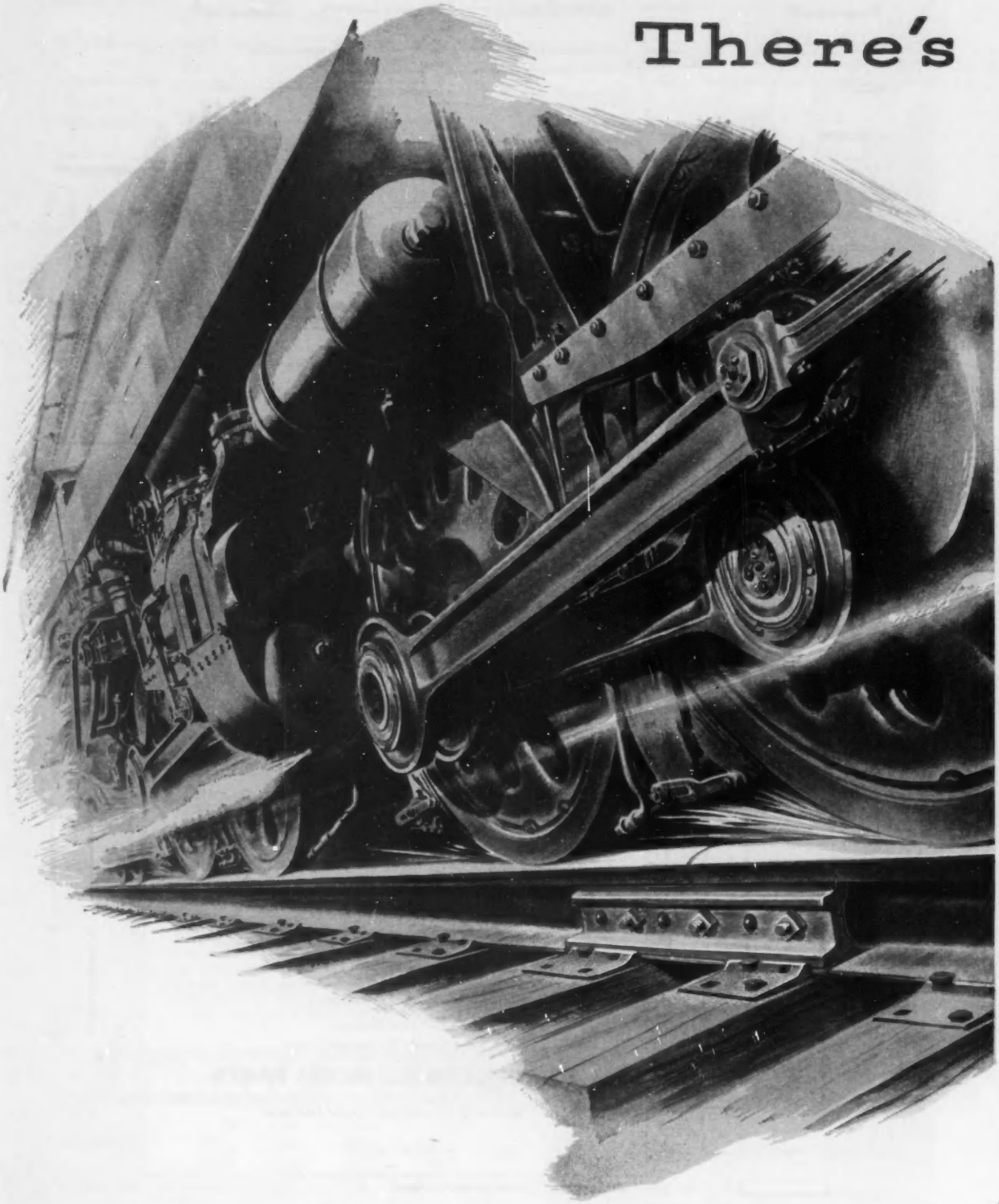
Send for our Condensed Catalog. It shows many more of the parts we can produce economically for you. And send us a sample part or blueprint for our quotation—it can save you money.

THE TORRINGTON COMPANY
Specialties Division
230 Field Street, Torrington, Conn.

TORRINGTON SPECIAL METAL PARTS

Makers of Torrington Needle Bearings

There's



Safety in Numbers

Railroads can't afford to gamble with safety. That's why it is standard railroad practice to use but one material in the insulation of the rail-joints . . . the literally thousands of them . . . on which depends the operation of electric signal and safety systems.

That material is *Vulcanized Fibre!* No other material has the ability to withstand, year after year, the exposure and pounding impact of such punishing service conditions.

Vulcanized Fibre is really tough . . . long lasting . . . dependable. It has a unique combination of electrical, mechanical, and physical properties . . . and can be worked and machined like metal. It weighs only half as much as aluminum . . . and is relatively low in cost.

So, if you would like to make a product, or a part, better . . . lighter . . . or at lower cost . . . National Vulcanized Fibre might be your answer. Just get in touch with us. A National sales engineer will be glad to help.

Want the facts and specifications on weights, tolerances, forms and grades available? Or dielectric strengths, colors, suggested applications, machining and forming techniques? Here's the whole story in one thumb-tabbed package. It's a catalog you can't afford to be without, so ask the National representative nearest you for your copy. He's listed in the classified directory. Or write to National Vulcanized Fibre Co., Dept. B-5, Wilmington 99, Delaware.

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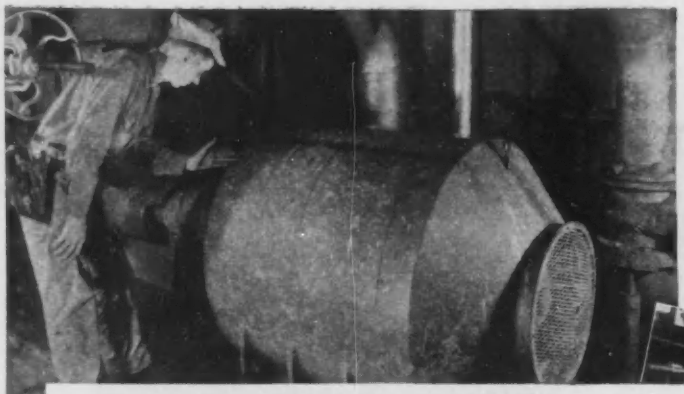

ALLIS-CHALMERS
Totally-Enclosed Fan-Cooled MOTORS

INDOORS or OUT

DIRT and CORROSION

Can't Hurt These Motors

Here is a totally-enclosed type of motor that will solve many of your dirt and corrosion problems. Install anywhere, indoors or out.

Cooling System is Self-cleaning

Cooling air is carried through the heat-exchanger tubes with sufficient velocity to expel practically any kind of dirt. If oily or sticky dirt should cling, tubes can be ramrodded clean in a few minutes because tubes are straight and tube ends are exposed.

Choice of Corrosion-resistant Materials

You can lick corrosion with this motor, too. Tubes are available in a variety of materials to meet practically any corrosive atmospheric condition. Allis-Chalmers tube-type motors have long and successful experience in such difficult applications as caustic plants, refineries and petrochemical plants, power plants with fly ash problems and many others.

Next time you need a motor for a dirty or corrosive location or for outdoor operation in all kinds of weather, call your Allis-Chalmers District Office. Get complete information on Allis-Chalmers tube-type totally-enclosed, fan-cooled and explosion-proof motors. Or write Allis-Chalmers, Milwaukee 1, Wisconsin, for Bulletin 51B7149. Available in ratings on frames larger than NEMA 505 up to 3000 hp. A-4222

Texrope and Vari-Pitch are Allis-Chalmers trademarks.

Sold . . .
Applied . . .
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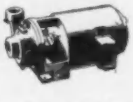
CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

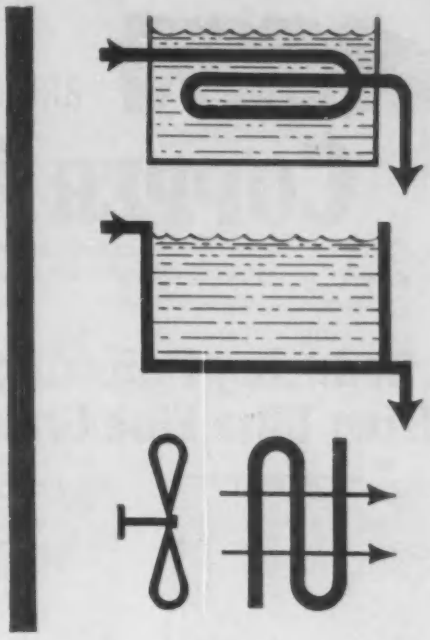
TEXROPE **V-belts in all sizes and sections, standard and *Vari-Pitch* sheaves, speed changers.**



PUMPS — Integral types from ¾ in. to 72 in. discharge and up.

ALLIS-CHALMERS

How to keep heating or cooling "bugs" out of your equipment



Design bugs never "bite," it seems, until *after* equipment is in the user's plant. And usually, where heating or cooling is involved, the bugs are caused by improperly specified or installed steam specialties or temperature regulators.

For example, the wrong type of steam trap installed by your customer can cause equipment to waterlog. Inadequate air venting will cut down heat transfer and result in slow start-ups. The wrong type of temperature controller may cause erratic temperatures in the unit.

Whatever the cause, the efficient operation of your equipment is jeopardized. Problems like these are better solved *before* they reach your customers. Whether you specify or install steam specialties or temperature controllers you can avoid trouble by calling in Sarco first.

Sarco's experience as designers and makers of a complete line of steam traps and temperature regulators has helped many equipment manufacturers save time, trouble and expense. Sarco engineers are prepared to offer sound, impartial recommendations on all phases of steam trapping and temperature control.

For interesting case histories describing the solution of problems similar to yours, write today to Sarco Company, Inc., Empire State Building, New York 1, N. Y.

A Partial List of Satisfied Sarco Customers

Ex-Cell-O Corp.
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SARCO

SAVES STEAM

improves product quality and output

STEAM TRAPS • TEMPERATURE CONTROLLERS • STRAINERS

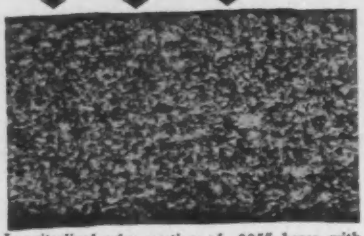
Thermostatic Steam Traps	Float-Thermostatic Steam Traps	Camlift Bucket Steam Traps	Liquid Expansion Steam Traps	Thermodynamic Steam Traps	Strainers	Electric Valves (solenoid)	Electric Temperature Controllers	Self-operated Cooling Controls
Bulletin 250	*Bulletin 450*	*Bulletin 360*	*Bulletin 260*	*Bulletin 255*	*Bulletin 1200*	*Bulletin 1055*	*Bulletin 1025*	*Bulletin 700*

BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

Bridgeport MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

Reducing Polishing Costs By Using Ultra Fine Grain Structure



Longitudinal edge section of .025" brass with .010 mm grain size after it was stretched in making an Erickson cup. Mag. 75X. Note smooth surface on top edge (surface of metal)—see arrows.

Longitudinal edge section of .025" brass after it was made into an Erickson cup. Mag. 75X. Note bumpy condition on top edge (surface of metal)—see arrows.

In recent years the trend has been toward lighter gauges of brass and copper strip for fabrication purposes in order to keep metal costs to a minimum and still retain the intrinsic advantages of copper-base alloys.

Metal with thinner gauges and smaller cross-sectional areas possesses a lower breaking strength and less ability to withstand stretching. However, these disadvantages are being offset in part, at least, by applying special metallurgical know-how during processing of thin gauge metals.

Effect of Grain Size

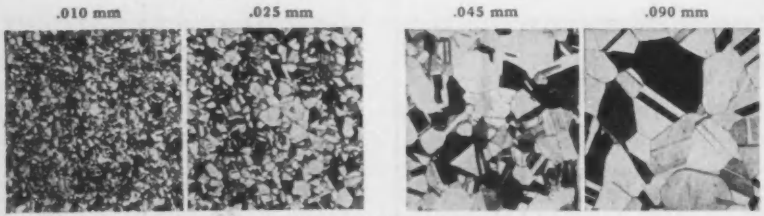
It has long been known that grain size affects such physical properties as tensile strength, per cent elongation, Rockwell hardness and ductility. The smaller the grain size, the higher the tensile strength and the greater the hardness. For example, annealed 70-30 Brass with a grain size .045 mm averages about 48,000 pounds per square inch in tensile strength as compared with about 58,000 pounds per square inch for brass with a grain size of .010 mm.

For many years we have been supplying annealed brass on thin gauges with a grain size as fine as .010 mm. Today a grain size as low as .005 mm is applied for some applications. Microstructures of such fine grain sizes are designated as Ultra Fine Grain.

Ultra Fine Grain brass approaches normal brass, quarter hard temper, (reduced 1 number B&S) in tensile strength, Rockwell hardness, stiffness and springiness. However, its ductility is somewhat higher than quarter hard temper. It is suitable for shallow drawing, forming and stamping.

Roughness from Stretching Explained

When metal is stretched beyond its yield point, movement takes place both at the slip planes in the crystals as well as along the crystal boundaries. Illustrated are samples of brass which were annealed with .010 mm and .080 mm grain sizes, then made into Erickson cups. Micrographs of the longitudinal edge sections of these samples clearly show that the high points in coarse grain metal are considerably higher than those in fine grain metal. Obviously, it takes more polishing effort to cut down the higher points of coarse grain metal than it does of fine grain metal.



Etch $NH_4OH + H_2O_2$ Mag. 75X

Ultra Fine Grain Reduces Polishing

Ultra Fine Grain brass is generally satisfactory for items made by forming and stamping. Forming is an operation which changes a blank to a cup such as a lamp base or clock case without materially changing the thickness of the metal or appreciably stretching it on the bottom or side walls. The fine grain structure gives the metal adequate strength to withstand the forming operation without breaking. Any stretching which develops does not result in the formation of a rough surface. Consequently, a minimum of polishing is required to bring up a high lustre.

Stampings such as escutcheons and fishing lures, which carry designs either raised or sunk into the metal, can also advantageously be made from Ultra Fine Grain brass. Here both sharp impressions and a smooth surface for economical polishing are attained.

Ultra Fine Grain brass is excellent for frames for fireplace screens where the metal is bent 90°. Smooth corners and satisfactory stiffness result. Economies in finishing, yet highest quality are attained.

Fine grain brasses cannot be used indiscriminately because they are apt to be stiff and springy. However, metal fabricators may be able to design parts around their capabilities and economies although special tooling may be required.

Among the many applications for Ultra Fine Grain metal are ornamental jewelry, pocketbook frames, vanities, lipstick containers, lamp bases, escutcheons, flanges, building hardware, fireplace screen frames, gift items, fishing lures, clock cases, metal boxes, lamps, lighting fixtures and many other similar applications.

Investigate Before Ordering

When considering Ultra Fine Grain for a new application, using simple or moderate forming operations, full information should be furnished to the mill to make sure that such material will withstand the necessary mechanical operations. Contact our nearest Sales Office if you are interested in obtaining greater economies in your finishing operations through using brass or copper designed for your specific needs. (1493)

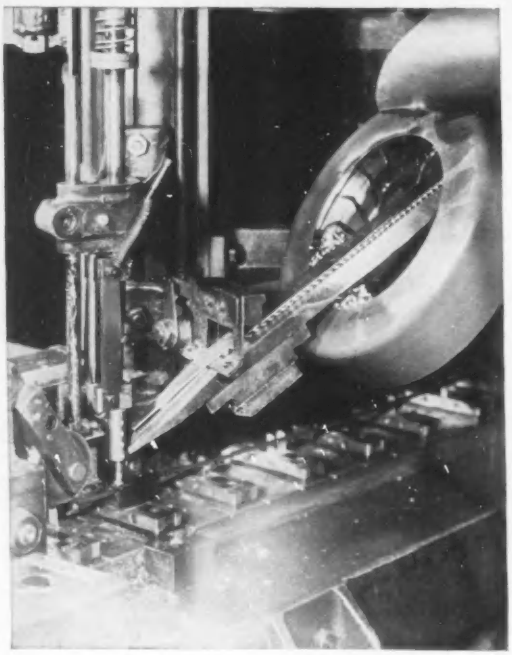
PHILLIPS Cross Recessed Head SCREWS

marks the spot

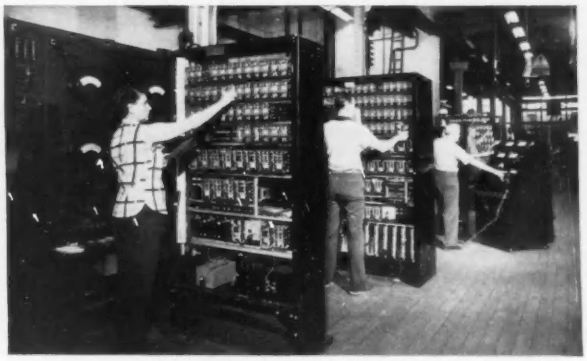
the mark of X-tra quality

Users Praise Phillips Cross

THE SONOTONE SCREENING AUDIOMETER uses Phillips screws to anchor the calibration indicator panel, as shown here by Raymond Ciruzzi. "The non-shearing head advantage of the Phillips screw is eliminating costly and time-consuming recalibration of the dials," reports P. R. Werner, engineer in charge of Audiometer. Every screw used on the Audiometer's front panel and panel doors, including panel hinges, is a Phillips screw.

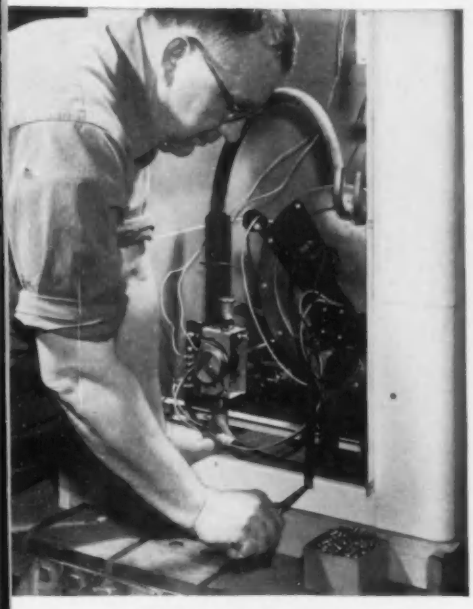


WIREMOLD'S "PLUGMOLD" — a metal molding, wired with outlets — is here assembled on Wiremold's automatic assembly machine. Drum, right, feeds screws to power driver, left. Driver instantly engages head of screw, making a firm bond between electrical conductor and receptacle. "Without self-centering Phillips screws," says Eugene Pitcher, Wiremold plant engineer, "we simply would not be able to utilize this automatic assembly method. With it, we increased our production efficiency per man by at least 20%."



THE "BRAIN", OR CONTROLLER, OF AN OTIS ELEVATOR contains about 100 individual switches each using 15–20 Phillips screws or nearly 2000 screws per controller. Evelyn Campbell, Edward Nevermann, Ernest O'Donnell and Albert Wilson here inspect controllers by means of instruments that double check circuits for accurate contacts. "We are so thoroughly convinced of the superiority of Phillips screws," says S. B. Sanford, Otis consulting engineer, "that we have incorporated them in all our engineering drawings."

-Recessed-Head Screws



APEX ELECTRICAL MANUFACTURING COMPANY relies on Phillips type screws for increased proficiency of production. "We use them," states William A. Haverlock, Superintendent of Assembly, "because of ease of assembly, tighter and more secure fastening, less damage to screw, bit or enamel due to driver slippage, safety factor and better holding qualities over prolonged use." An Apex automatic dishwasher is here being assembled.

DOMINION ELECTRIC'S IRON uses chrome plated Phillips screws to fasten shell. "Phillips screws," says W. A. Reis, product engineer, "definitely speed up production especially in 'blind' locations, improve appearance of our products and permit us to design appliances which require the screw to be installed from a different angle. We are getting features from Phillips head screws that we cannot get from any other screw."

TITAN THERM-O-DIAL HEATERS use the exclusive heating element being assembled above. It is secured at each end by a Phillips screw. Note hand, at right, about to place screw in upright position on special jig for speedy assembly. "With Phillips, we were able to increase production," says Richard K. Fleischman, Titan vice-president, "get a much tighter metal-to-metal bond, secure a more attractive design and produce a lower cost item through decreased production time."

MANUFACTURERS OF PHILLIPS CROSS-RECESSED-HEAD SCREWS

THE FASTENERS OF TODAY... AND OF THE FUTURE

X marks the spot . . . the mark of extra quality

Look to these manufacturers for X-tra quality Phillips Cross-Recessed-Head Screws

AMERICAN SCREW COMPANY
Willimantic, Connecticut

ATLANTIC SCREW WORKS, INC.
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Hartford 1, Connecticut

THE BLAKE & JOHNSON CO.
Waterville 14, Connecticut

CENTRAL SCREW COMPANY
3501 Shields Avenue
Chicago 9, Illinois

CONTINENTAL SCREW COMPANY
New Bedford, Massachusetts

THE EAGLE LOCK COMPANY
Terryville, Connecticut

ELCO TOOL AND SCREW CORPORATION
Rockford, Illinois

GREAT LAKES SCREW CORPORATION
13631-51 So. Halsted St.
Chicago 27, Illinois

THE H. M. HARPER COMPANY
Morton Grove, Illinois

THE LAMSON & SESSIONS COMPANY
1971 West 85th Street
Cleveland 2, Ohio

NATIONAL LOCK COMPANY
Rockford, Illinois

THE NATIONAL SCREW & MANUFACTURING CO.
2440 East 75th Street,
Cleveland 4, Ohio

PARKER-KALON Division General American Transportation Corporation
200 Varick Street,
New York 14, N. Y.

PHEOLL MANUFACTURING CO.
5700 Roosevelt Road
Chicago 50, Illinois

ROCKFORD SCREW PRODUCTS CO.
Rockford, Illinois

SCOVILL MANUFACTURING COMPANY
Waterville 14, Connecticut

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THE SOUTHINGTON HDWE. MFG. COMPANY
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WALES-BEECH CORPORATION
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Rockford, Illinois

4.4.3 — 5/54
Printed in U.S.A.

Get on the right track to BEAT WEAR ...use AMPCO* METAL

ONE of the easiest ways to beat wear is to use Ampco Metal. That's why more and more designers and plant-operating men turn to these versatile aluminum-bronze alloys. They know that Ampco Metal builds extra toughness and stamina into their machines — toughness and stamina that mean longer service life, more dependable performance, lower costs.

And unusual resistance to wear isn't the whole story. Ampco Metal has high compressive strength — doesn't squash out. It resists abrasion, erosion, corrosion. It has high impact and fatigue values, and excellent bearing qualities.

You can get Ampco Metal in practically any form you need—sand and centrifugal castings, sheet, plate, forgings, bars, tubes, welding wire and electrodes.

Beat wear! Use Ampco Metal in both your product and plant — for that all-important extra margin of safety and dependability. For the complete story, contact your nearest Ampco field engineer or send coupon.

*Reg. U. S. Pat. Off.

Nordberg Mfg. Co.
Milwaukee, Wisconsin

The Product: Nordberg Hydraulic Power Jack used to lift rails and ties from roadbed during reballasting or resurfacing.

The Problem: To keep wear in the moving parts of the hydraulic rams to a minimum. Because the piston and gland act as guides, close tolerances must be maintained. In addition, the hydraulic ram utilizes pressures of 3000 psi and, although the piston ram has "O" rings with back-up washers, extremely close fits must be maintained between piston and gland to hold this pressure.

The Solution: AMPCO METAL for both piston and gland.

The Results: Thanks to the ability of Ampco Metal to resist wear, proper clearances and tolerances are maintained. The result—dependable performance, greater output.

IT'S PRODUCTION-WISE TO AMPCO-IZE

Nordberg Track Jack in operation. Machine consists basically of two hydraulic rams, each capable of lifting 24,000 lbs. Ampco Metal is used in the moving parts of the hydraulic rams because of its excellent resistance to wear.

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Throttle Control...

Simplified with

HEIM *Unibal* BEARINGS

When the new improved Hyster Turret Truck was introduced, some of the improvements included simplification and strengthening of the throttle control mechanism.

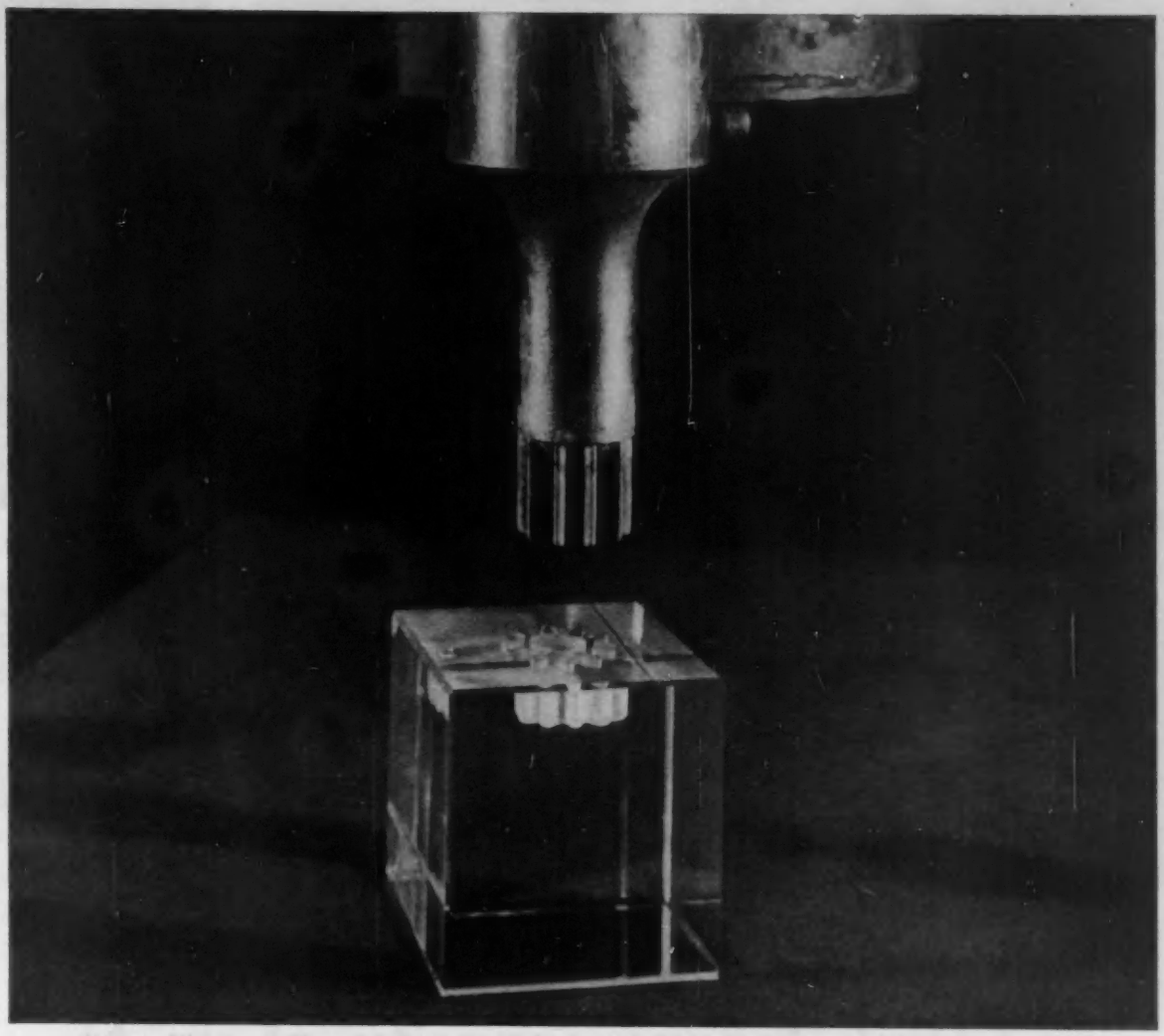
More durability, longer life, and trouble-free service were accomplished through the wider use of Heim Unibal Bearings — often referred to as spherical self-aligning bearings.

THE SINGLE BALL CORRECTS MISALIGNMENT IN EVERY DIRECTION.

Heim Unibal Spherical Bearings and Rod Ends are the solution to most problems of transmitting motion at varying angles. Rod Ends are available in a complete range of bore and thread sizes in both male and female types.

Write for Complete Catalog and a free sample of Unibal.

THE HEIM COMPANY
FAIRFIELD, CONNECTICUT



Using high-frequency vibrations and low-cost abrasives, the Ultrasonic Machine Tool carves holes and patterns of all shapes in hard-to-work materials. Development of the tool climaxed more than 10 years of research and experimental work.

How SILENT SOUNDS CUT HOLES you can't drill

This common steel gear bites its way into a glass cube as smoothly as it would mesh with its mate.

And that's *something*, for chiseling through glass is quite a trick, even with a tool designed for the job.

Yet, as you can see, it's being done right here. And the machine that does it can also sharpen the hard metal tools used to cut other metals. It can cut diamonds without the use of diamond powder. Some day, it may even eliminate the heat-generated pain caused by your dentist's whirling drill, or provide a vastly improved method for breaking up kidney- and gallstones.

Now how does this revolutionary tool work? *By ultrasonic vibration.* It vibrates 27,000 times a second! Every vibration pounds water-borne abrasive against the surface you're cutting, and steadily chisels away tiny particles.

It took time to produce and control these vibrations. Over 10 years of research and trial-and-error experimentation! Then—with the help of Inco Nickel — the successful method was perfected.

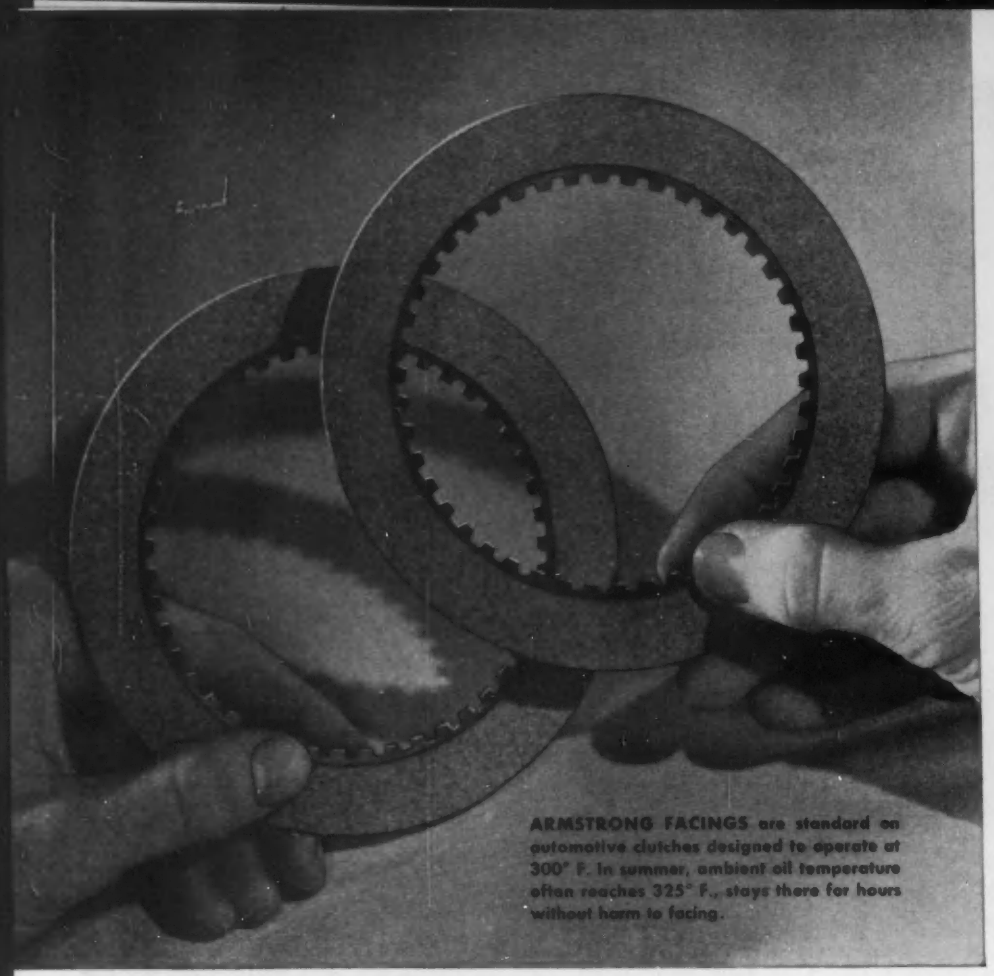
Pure nickel, when placed in an electromagnetic field, contracts much more than other commercial metals, and returns to its original length. (Physicists call this "magnetostriction.") It is this motion — stepped up a hundredfold — that produces the vibrations which give the tool its bite.

There are many similar useful qualities found in Inco Nickel Alloys. Between them, pure nickel and Monel provided the key to the problems of the ultrasonic machine tool. Another of our metals may help to open a door now locked to you. Let's get together and work out that problem of *yours* — soon.

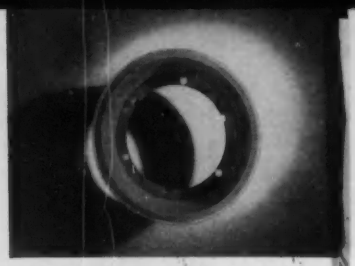
THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

Inco Nickel Alloys

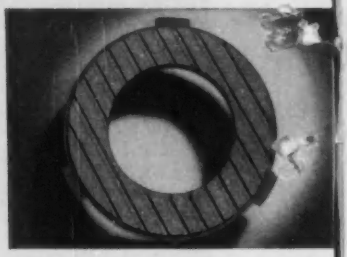
Monel® • "R"® Monel • "K"® Monel "KR"® Monel • "S"® Monel • Inconel® Inconel "X"® • Inconel "W"® • Incoloy® Nimonic® Alloys • Nickel • Low Carbon Nickel • Duranickel®



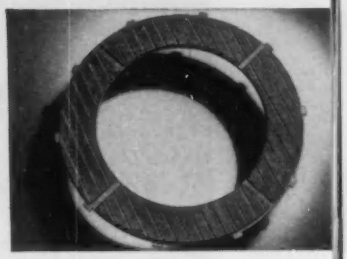
ARMSTRONG FACINGS are standard on automotive clutches designed to operate at 300° F. In summer, ambient oil temperature often reaches 325° F., stays there for hours without harm to facing.



Drill press tapper cone clutch runs dry, allows almost instantaneous engagement for maximum production rates.



Use of cork in washing machine's wet clutch cut needed facings from 8 to 3.



Cork-and-rubber facing gives motorcycle fast getaway, even on sandy roads, saves seconds on each shift.

CORK CLUTCH FACINGS:

High torque capacity at up to 300° ambient oil temperature

Many wet clutches with cork facings are run regularly at ambient temperatures in the 250°–350° F. range, almost double the commonly accepted textbook standard. In fact, flash temperatures during engagement actually go even higher without damage to the facing.

Cork's high coefficient of friction over a wide range of temperatures and pressures gives you extremely high torque capacity for a given facing area. By using cork, you can usually reduce the number or size of plates needed in a clutch, or run it at a lower engagement pressure without sacrificing torque capacity. In addition, cork facings reduce assembly costs and eliminate the need for finishing grinding, so the savings possible with cork are often sizable.

Cork facings are durable, too. In fact, ten different makes of automobiles now have Armstrong-made cork facings in their automatic transmissions. Experience has shown that these facings will run for the life of a car without wearing out or breaking down.

Armstrong is the world's leading supplier of cork-compounded facings. A wide variety of cork composition, cork-and-rubber, and cork-fiber friction materials are available from Armstrong . . . as well as unique testing facilities which help you select a facing with a minimum of time and trouble.

For the complete story on cork-compounded facings, or for specific help in picking a facing for a new clutch design, write Armstrong today. Address Armstrong Cork Company, Friction Materials Department, 7205 Irvin Street, Lancaster, Penna.

ARMSTRONG'S FRICTION MATERIALS

How the design, development and production team at Burgess-Norton made possible

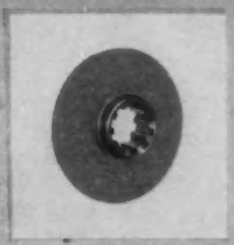
Cost Savings of 17% On this Clutch Hub

Here is another example of how redesign for modern production methods produced a better part at lower costs. This clutch hub was formerly made from a machined forging. By combining a screw machined part and a stamping through hydrogen-copper brazing, as shown below, production costs were reduced 17% . . . greater control on flange tolerances obtained, and eight stop lugs could be used instead of only four.

The original forged hub design required greater machining time, and often had excessive scrap because of flange thickness variations.

Basic components of the new design are a stamped and formed flange and a screw machined center hub.

The two parts are then assembled with copper rings and brazed under controlled atmosphere conditions to eliminate oxidation.



After the hydrogen-copper brazing operation, the hub splines are cut on horizontal broaching machines.

Final operations are in the stamping department, where spring slots are pierced and stop lugs formed.

COMPLETE FACILITIES
FROM DESIGN THROUGH PRODUCTION FOR BETTER PARTS AT LOWER COSTS

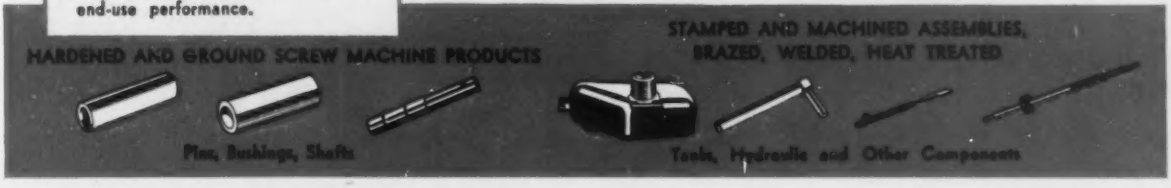
Engineering is one of the important cogs in the complete service offered to industry by B-N. This experienced group works closely with production and metallurgy in designing for low cost manufacture and better end-use performance.

Burgess-Norton facilities and equipment are extremely diversified for the economical production of a wide range of precision parts, and include complete engineering, development, and metallurgy departments. This engineering service is available to you without obligation. If you have a parts production problem, we believe it will pay you to check into Burgess-Norton facilities. Send prints, specifications, or samples . . . or, if you prefer, one of our sales engineers will call, at your convenience.

BURGESS-NORTON MFG. CO.

GENEVA, ILLINOIS

Serving Industry For Over 50 Years

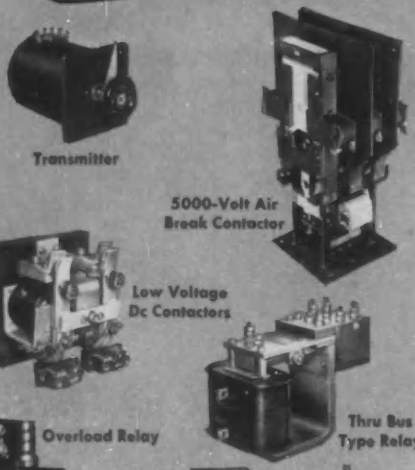

HARDENED AND GROUND SCREW MACHINE PRODUCTS
Pins, Bushings, Shafts
STAMPED AND MACHINED ASSEMBLIES, BRAZED, WELDED, HEAT TREATED
Tools, Hydraulic and Other Components

When you reach the problem of CONTROL

We Can Help!

ALLIS-CHALMERS

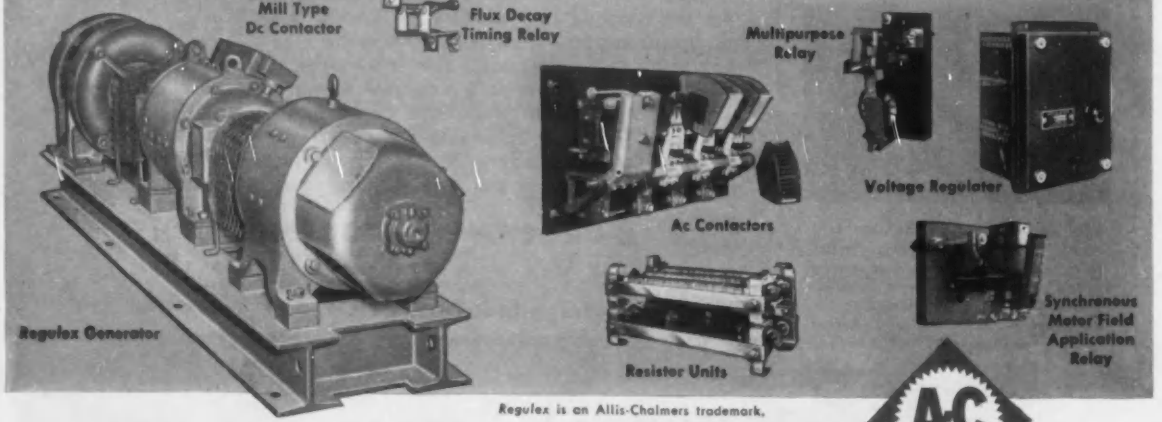
CONTROL



In your equipment design, you will encounter a control problem. Maybe its solution calls for the application of an off-the-shelf device. Maybe it calls for a slight modification of standard equipment. Maybe it requires specially designed control.

Here's where your Allis-Chalmers field engineer can help you. He is an application specialist . . . ready and able to work with your staff to determine your control needs. His suggestions and analyses are backed by the Allis-Chalmers engineering departments . . . by the experience gained in solving thousands of control problems . . . by complete testing and research facilities.

Specify Allis-Chalmers control and get an all-important plus — *personal, expert attention to your particular control problem.* Contact your nearby A-C representative or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-4052



Regulex is an Allis-Chalmers trademark.

ALLIS-CHALMERS

BASE HIT—NO RUNS

Stockings don't snag, shoes don't get scuffed on this swivel chair base molded in one piece from BAKELITE Phenolic Plastic. The surface is smooth and shiny—no burrs or rough edges. It has no applied finish because the color—gleaming black or rich walnut—is the intrinsic color of the plastic.

The lightweight plastic construction helps make the chair easy to handle. And the mechanical strength is so high that the manufacturer's guarantee is able to state that a 1000 lb. weight dropped one inch onto the plastic base had no harmful effect.

Large size meets low cost in this molding. It's made from a BAKELITE General-Purpose Phenolic. Other BAKELITE Phenolic Molding Materials include heat-resistant phenolics, electrical insulating grades, and special types for unusual operating requirements.

These BAKELITE materials cover a great range of service properties. They are backed by manufacturing and development resources of BAKELITE Company. To learn how they can bring sales and production advantages to your operations, write Dept. XA-10.

Swivel chairs with bases of BAKELITE Phenolic Plastic are made by **Dependable Mfg. Co.**, Omaha, Neb.

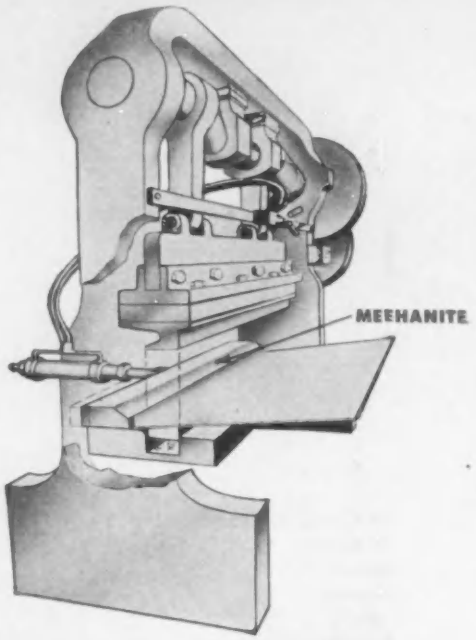
See BAKELITE'S exhibit, National Plastic Exposition, Cleveland, Ohio June 7-10.

BAKELITE
TRADE-MARK
PHENOLIC PLASTICS

TRADE MARK
BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N. Y.
In Canada: Bakelite Company
Division of Union Carbide Canada Limited
Belleville, Ontario

The MEEHANITE® Casting Reporter

MEEHANITE BACK GAGE SAVES $100 PER DAY



In order to reduce production costs on a power brake, the manufacturer devised an automatic flanging die with a movable back gage which permitted the forming of 6 different bends with a single set-up. Materials handling savings amounted to $100 per day.

Originally the back gage, key to the operation, was made of hardened and ground steel but wore rapidly as a result of the horizontal thrust of the sharp edges of the steel sheet being worked.

The use of Meehanite metal for this gage solved the wear problem and three years after the installation the unit had gone through 9 million operations without removal for maintenance, repair, or straightening.

The manufacturer states **"The ability of Meehanite metal to meet the service requirements permitted the successful design and operation of the machine."**

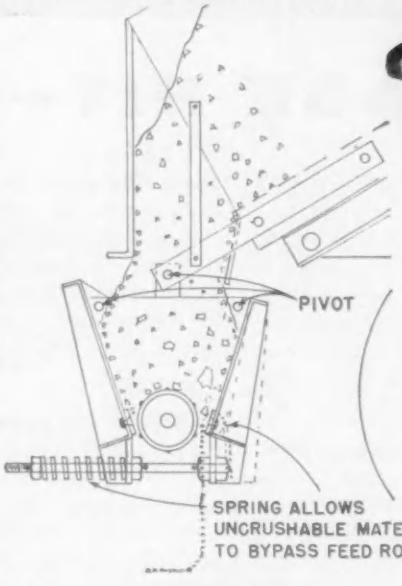
MEEHANITE SPROCKET INCREASES SERVICE LIFE THREE TIMES

In a sand and cinder spreader used for skid-proofing icy roads the operation of the material hopper is dependent upon a drive sprocket unit. The material being spread is fed between a feed roll and compression springs allow movement of the hopper sides in the event of hard, uncrushable pieces being passed.

The drive sprocket, when cast in high property bronze gave trouble through shearing at the clutch face when subjected to the high stresses created when hard and large lumps of material went through the hopper.

When produced as a Meehanite casting, the sprockets, after heat treatment, provided sufficient impact strength and abrasion resistance to eliminate breakage.

The manufacturer reports **"that substantial cost savings have resulted and the operating life of the Meehanite sprocket is generally three times that of the previous material."**



HOPPER UNIT

WHAT MEEHANITE CASTINGS HAVE DONE FOR THEM

HEAT TREATED MEEHANITE SCORING ROLLS REDUCE COST- IMPROVE WEARING QUALITIES

The ability to heat treat Meehanite castings and obtain increased hardness and greater wear resistance is revealed in the use of these castings for corrugated paper box scoring rolls.

The abrasive forces set up by corrugated paper are high and it is essential that the grooves and beads of the scores be machined to a high degree of accuracy. This, of course, is costly, and makes each days' service life important.

One large manufacturer of corrugated paper boxes declares: **"We use Meehanite rolls exclusively and find that the life of the units has been more than doubled since the specification of this material."**

ONLY A MEEHANITE FOUNDRY CAN MAKE MEEHANITE CASTINGS

American Brake Shoe Co. . . . . Mahwah, New Jersey
The American Laundry Machinery Co. . Rochester, New York
Atlas Foundry Co. . . . . Detroit, Michigan
Banner Iron Works . . . . . St. Louis, Missouri
Barnett Foundry & Machine Co. Irvington and Dover, New Jersey
E. W. Bliss Co. . . . . Hastings, Mich. and Toledo, O.
Builders Iron Foundry . . . . . Providence, Rhode Island
Compton Foundry . . . . . Compton, Calif.
Continental Gin Co. . . . . Birmingham, Alabama
Crawford & Doherty Foundry Co. . . . . Portland, Oregon
The Cooper-Bessemer Corp. . Mt. Vernon, Ohio & Grove City, Pa.
DeLaval Steam Turbine Co. . . . . Trenton, New Jersey
M. H. Detrick Co. . . . . Newark, N. J. and Peoria, Ill.
Empire Pattern & Foundry Co. . . . . Tulsa, Oklahoma
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Florence Pipe Foundry & Machine Co. . Florence, New Jersey
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Sonith Industries, Inc. . . . . Indianapolis, Ind.
Southern Illinois Foundry Co. . . . . Carmi, Ill.
Standard Foundry Co. . . . . Worcester, Massachusetts
The Stearns-Roger Manufacturing Co. . . Denver, Colorado
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Valley Iron Works, Inc. . . . . St. Paul, Minnesota
Vulcan Foundry . . . . . Oakland, California
Warren Foundry & Pipe Corporation . . Phillipsburg, New Jersey

Canada

Hartley Foundry Division — London Concrete Machinery Co., Ltd., Brantford, Ontario
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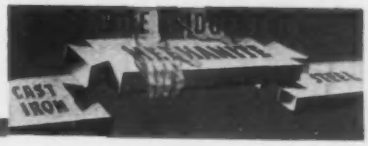
Write for your copy of **"The Handbook of Meehanite Metals"**

MEEHANITE METAL CORPORATION

714 North Ave., New Rochelle, N. Y.

This Advertisement Sponsored by Foundries listed above.



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Revere Aluminum extruded shapes have found wide applications in all types of carriers. This is due to their high strength, corrosion resistance, workability and lasting beauty.

When you specify Revere Aluminum you are assured of fine, uniform quality. Revere quality control lays special stress upon the particular needs of each customer, based on your own specific uses of Revere products.

Revere supplies extruded shapes, coiled sheet, drawn tube and forgings in a wide range of aluminum alloys.

For technical assistance in the design or manufacture of your own aluminum products, you are invited to utilize Revere's Technical Advisory Service.

REVERE ALUMINUM

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801
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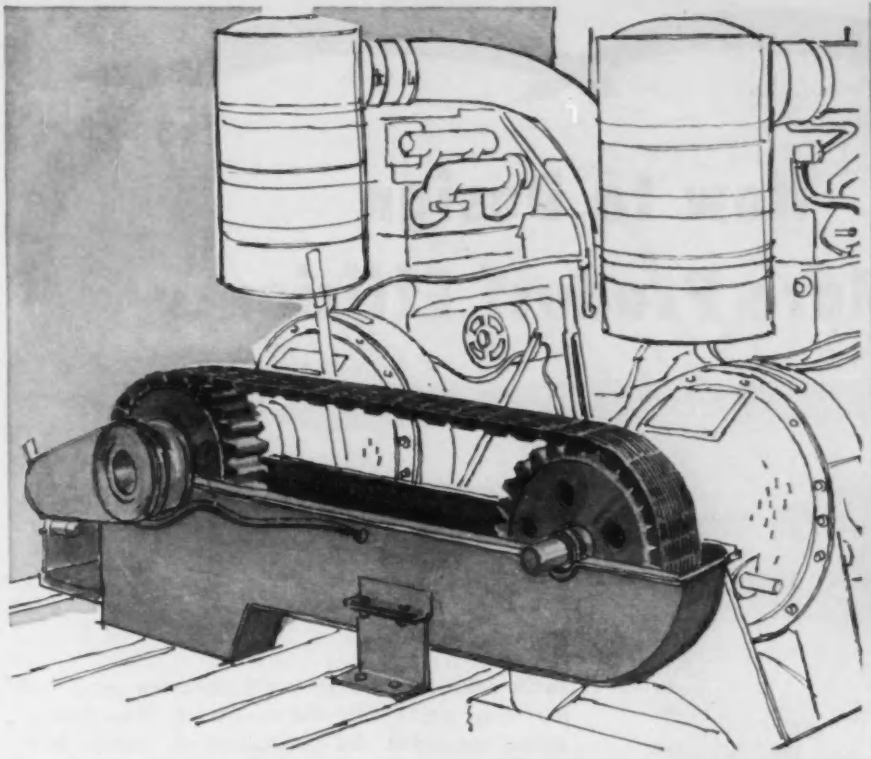
Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.— Sales Offices in Principal Cities.

SEE "MEET THE PRESS" ON NBC TELEVISION, SUNDAYS



Hy-Vo's many design and manufacturing refinements result in a drive with unusual power transmitting capacity. Note involute tooth design of Hy-Vo Sprockets . . .

. . . and the new, Hy-Vo Compensating Rolling Joint, which always shifts the pitch line automatically as the Hy-Vo Chain engages the involute teeth of the sprocket.

Chain follows a path truly tangent to sprocket pitch circle, virtually eliminating chordal action. A new, balanced link design greatly improves stress distribution.

How compounding with HY-VO could save you as much as $4,560

Now, you gain new advantages in buying and compounding smaller, higher speed engines with Morse Hy-Vo Drive.

You make major cost savings.

The total cost of two high-speed engines and the Hy-Vo Drives with which they are compounded, will usually be considerably less than a single large engine of equivalent horsepower. A brief look at some figures will show how this works . . .

For example, if you needed 250 continuous horsepower at 1200 rpm., you could: 1) Buy a manufacturer's 250 hp., 1200 rpm. engine, which lists for $13,380; 2) buy the 250 hp., 1800 rpm. engine for $11,930 (using Hy-Vo as a connection and reduction drive, also eliminates the costly flexible coupling normally required in choice No. 1); 3) or, use two 130 hp., 1800 rpm. engines, listing for a total of $8,820, and use Hy-Vo as your compounding drive.

With the 250 hp., 1800 rpm. engine, you save $1,450—more than enough to pay for your Hy-Vo Drive. Compounding two 130 hp., 1800 rpm. engines, you save $4,560 over base list cost of the 250 hp., 1200 rpm. engine.

From this saving you could pay for your Hy-Vo Drive and bank several thousand dollars. In most cases, too, Hy-Vo will be so narrow it will eliminate costs of outboard bearings and mountings, with the bonus that single-engine operation is possible under reduced power requirement.

Other power transmission methods generally have either inherent restrictions on rotative speeds and velocities that limit 200 hp. or larger engines to 1200 rpm., or are too costly. Hy-Vo has far greater upper limits, with relatively lower cost.

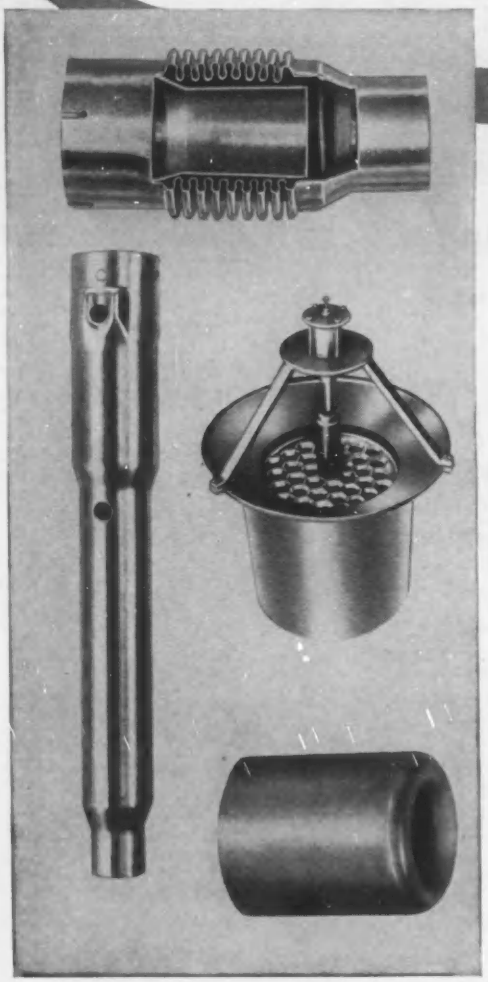
Because of exceptional rotative speeds and velocities, Hy-Vo brings you comparable savings in electric motors, too. Write us for details on compounding with Morse Hy-Vo Drive.

MORSE CHAIN COMPANY

7601 Central Ave. • Detroit 10, Michigan

FOR 24 REASONS, MASTERS OF MECHANICAL POWER TRANSMISSION SINCE 1893

How to Design for More Product Efficiency



In the column at the left you'll see a few parts that may help you in your next design job. They demonstrate, somewhat, the possibilities of "design freedom" that come when you design with Carpenter Stainless Tubing in mind, because they show that modification of design to achieve economical working or fabrication is unnecessary when you specify "Carpenter".

In short, Carpenter stainless gives you those working properties that make for easy fabrication and low reject rate even when severe drawing, swaging, flanging or upsetting are required. In addition, Carpenter is delivered "as specified" in analysis, dimension, finish, tolerance and temper, piece after piece, order after order. It does not vary in quality.

Why not design the cost-saving advantages of Carpenter tubing into your products. Call your nearest Carpenter representative—and prove for yourself that there is no "or equivalent" for Carpenter quality in stainless tubing.

The Carpenter Steel Company, Alloy Tube Division, Union, N.J.

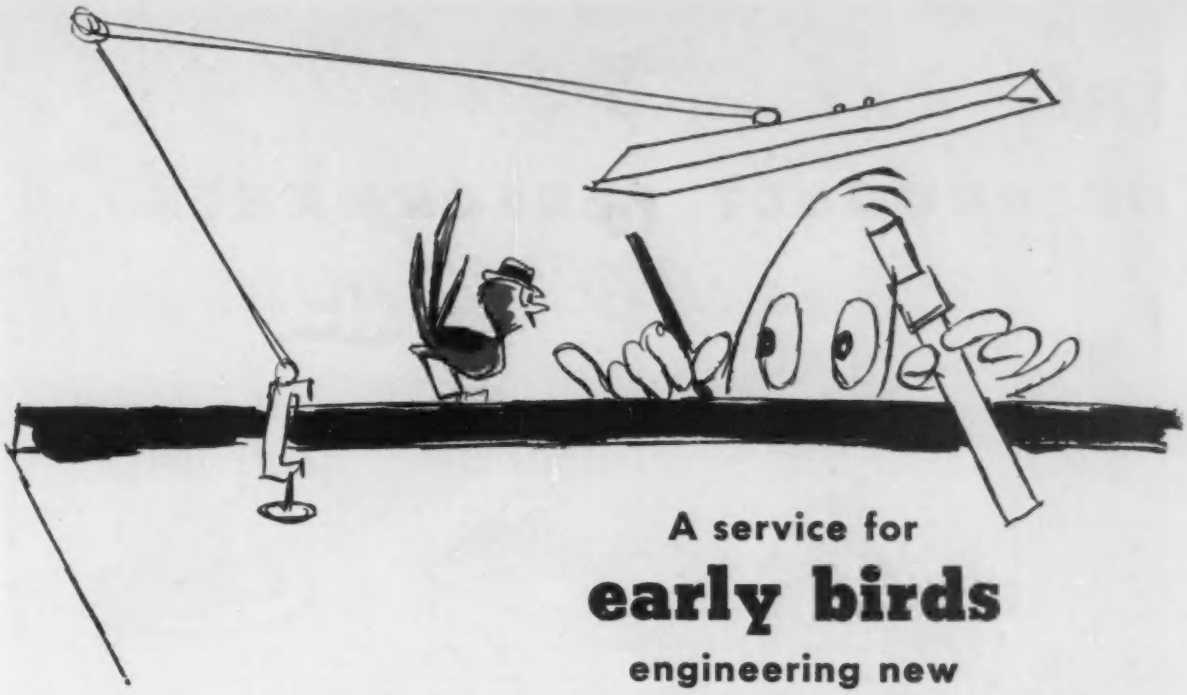
Branch Offices: Atlanta Chicago Pittsburgh Houston Newark San Francisco

Export Dept.: The Carpenter Steel Co., Port Washington, N.Y. "CARSTEELCO"

Carpenter

STAINLESS TUBING & PIPE

- guaranteed on every shipment



A service for
early birds
engineering new metal products

...early birds
are sheet metal design engineers and production men who make a point of getting the gremlins out of new products or new models in early stages...

Are you an EARLY BIRD? Then here's a new service to help you bring new products in on the beam.

First step is to take your design to engineers in National Lead's Tool & Stamping Department.

They'll check for production bugs and ways to cut costs. Then they'll cast try-out tooling in "Kirksite" A or "Nalcolite" plastic and stamp out components ... making any indicated changes.

If you need pilot models, they'll assemble them too.

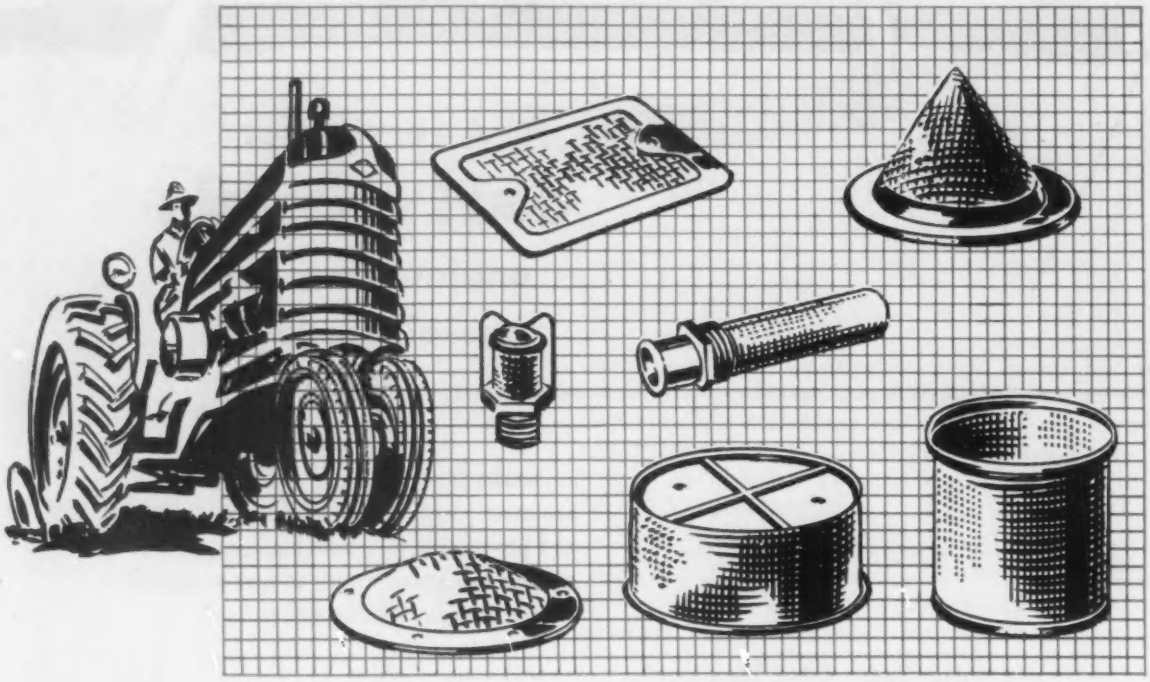
Once you're satisfied with dies, parts, and pilot models, National Lead turns the try-out tooling over to you ... for medium-run production or for duplication in steel tooling for very long runs.

Before full scale production is set up, most of your worries are over.

Have you a new design on the boards? Do you want more details on this new Tool & Stamping Department Service? Then just sing out.

National Lead Company 900 West 18th Street Chicago 80, Illinois

THIS WAY *dependability* OF PRODUCT PERFORMANCE IS *screened in*



Farm machinery must keep on keeping-on. From sewing seed to harvesting crops—everything must be done when the time is *right*.

That's why the wire screen cloth that does its job so unfailingly in so many small but vital farm machinery parts *is* important.

In the farm tractors' spark arresters, radiator grilles, brake linings, air cleaners and in all the various filters and screens using Reynolds wire cloth—failures are screened out and dependability is *screened in*.

From the fanning mills that sift and size the seed to the self-propelled harvesters—farm machinery makers know that they can rely on Reynolds to meet specifications precisely. For details see Sweet's Product Design File.

Consult Reynolds Engineers . . . no cost . . . no obligation.

Reynolds WIRE CLOTH for Industry

NS NATIONAL-STANDARD Company NILES, MICHIGAN

REYNOLDS WIRE DIVISION, NATIONAL-STANDARD CO., Box 200, **DIXON, ILL.**

Divisions of National-Standard Co.

ATHENIA STEEL...*Clifton, N. J.*	Flat, High Carbon, Cold Rolled Spring Steel
NATIONAL-STANDARD...*Niles, Mich.*	Tire Wire, Fabricated Braids and Tape
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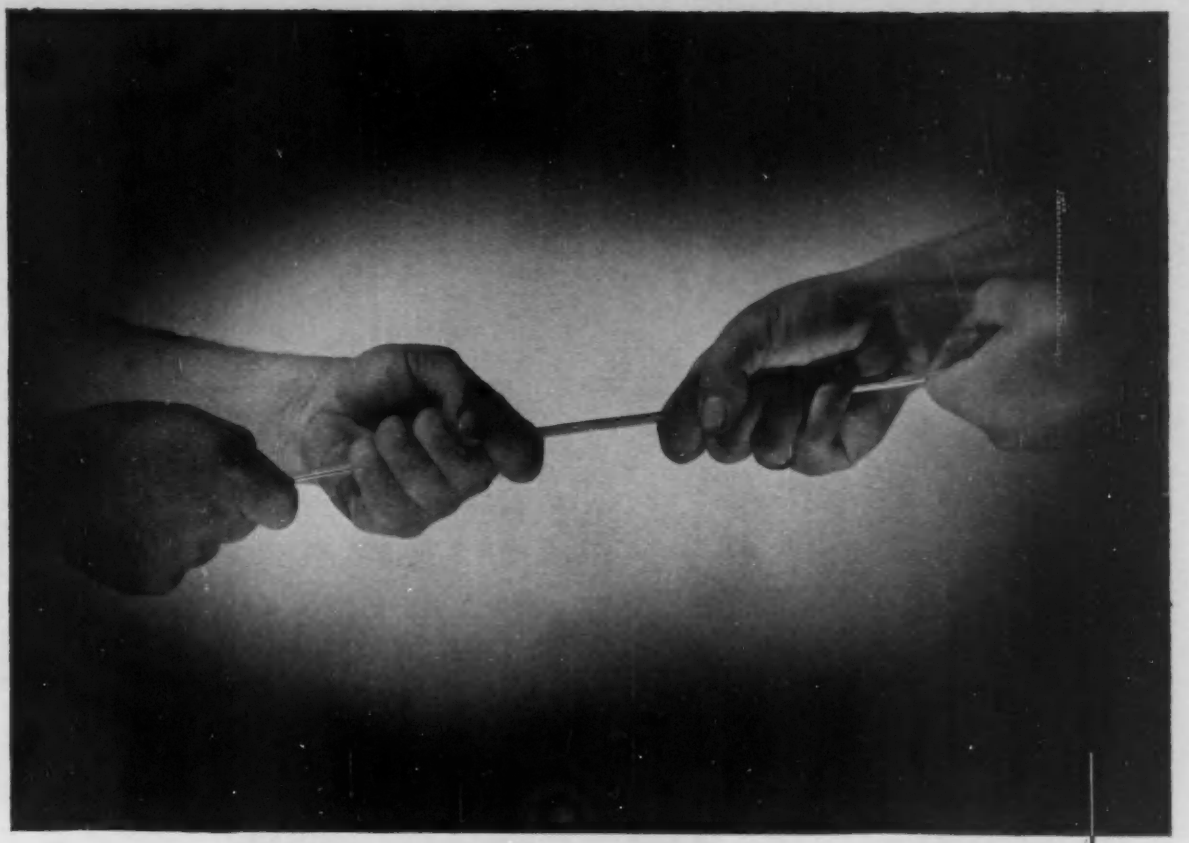
WORCESTER WIRE WORKS...*Worcester, Mass.*	Round and Shaped Steel Wire, Small Sizes



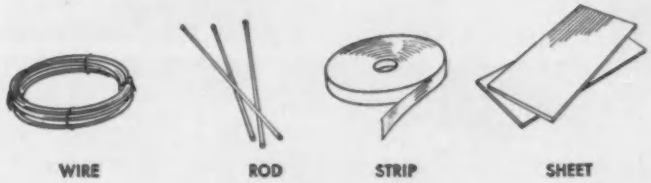
BERYLLIUM COPPER
WINS THE TUG-OF-WEAR

Beryllium Copper ("BeCu" for short), supplied by Riverside from ingot produced by Brush, has amazing physical properties. Great hardness with machinability, for instance, and *remarkable resistance to fatigue.*

Like pure copper, Beryllium Copper is non-magnetic and non-sparking. It is highly resistant to corrosion and wear. In the heat-treated state, its strength is almost double that of other copper alloys, with high electrical conductivity. BeCu is truly a versatile alloy.

THE RIVERSIDE METAL COMPANY, RIVERSIDE, N.J.
THE BRUSH BERYLLIUM CO., CLEVELAND 3, OHIO

RIVERSIDE
ALLOYS



WIRE ROD STRIP SHEET

BERYLLIUM BY
BRUSH

4% MASTER ALLOY INGOTS
CASTING ALLOYS INGOTS
Be METAL — ALLOYS — COMPOUNDS

"We're getting

twice the life from American "Quality Springs"

says NISSEN TRAMPOLINE CO. Cedar Rapids, Iowa

When George Nissen was a student in high school, he was fascinated with the antics of circus clowns on the safety nets. Using old inner tubes and a rope net, he built his first Trampoline.

As the National Intercollegiate Tumbling Champion from 1935 to 1937, Mr. Nissen built the Trampoline into a breathtaking national sport—it was accepted in 1948 for competition by the National AAU.

Each Nissen Trampoline contains 120 American Quality Springs, 8" long, 1⅛" in diameter. The mat has to "give" three feet, and there is only 3½ inches clearance when the mat is bottomed. For this reason, the springs must have exactly the right deflection.

Concerning safety, Mr. Nissen says this: "We used to have spring breakage before using American Quality Springs. It was dangerous because the spring could rebound and seriously injure someone standing nearby. Since we switched to American Quality Springs, we've never had a customer complaint, and the springs last twice as long as before."

If springs are an important part of your product, American Steel & Wire may be able to design a *better* one for you. We'll give you any quantity, any size, any kind of steel or finish—at the lowest price you ever thought possible.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL CORPORATION, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
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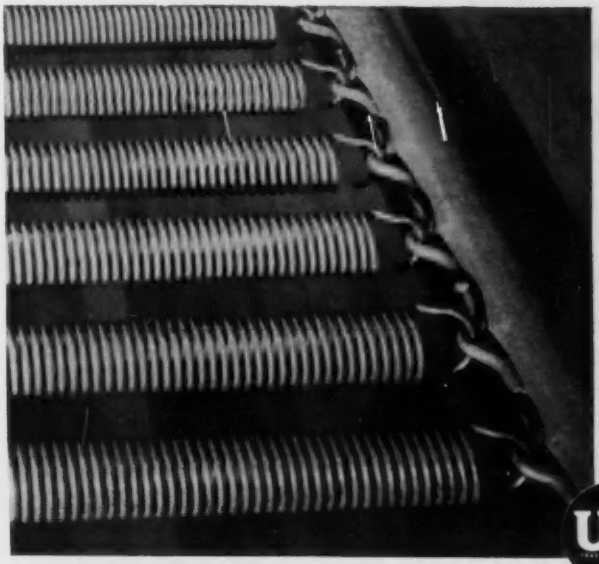
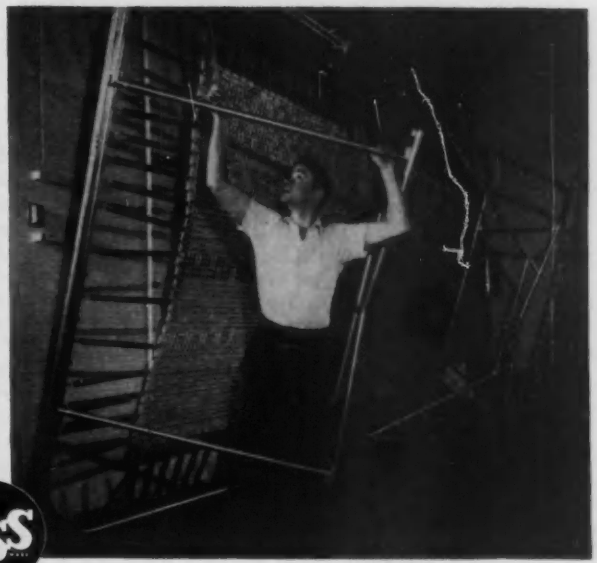


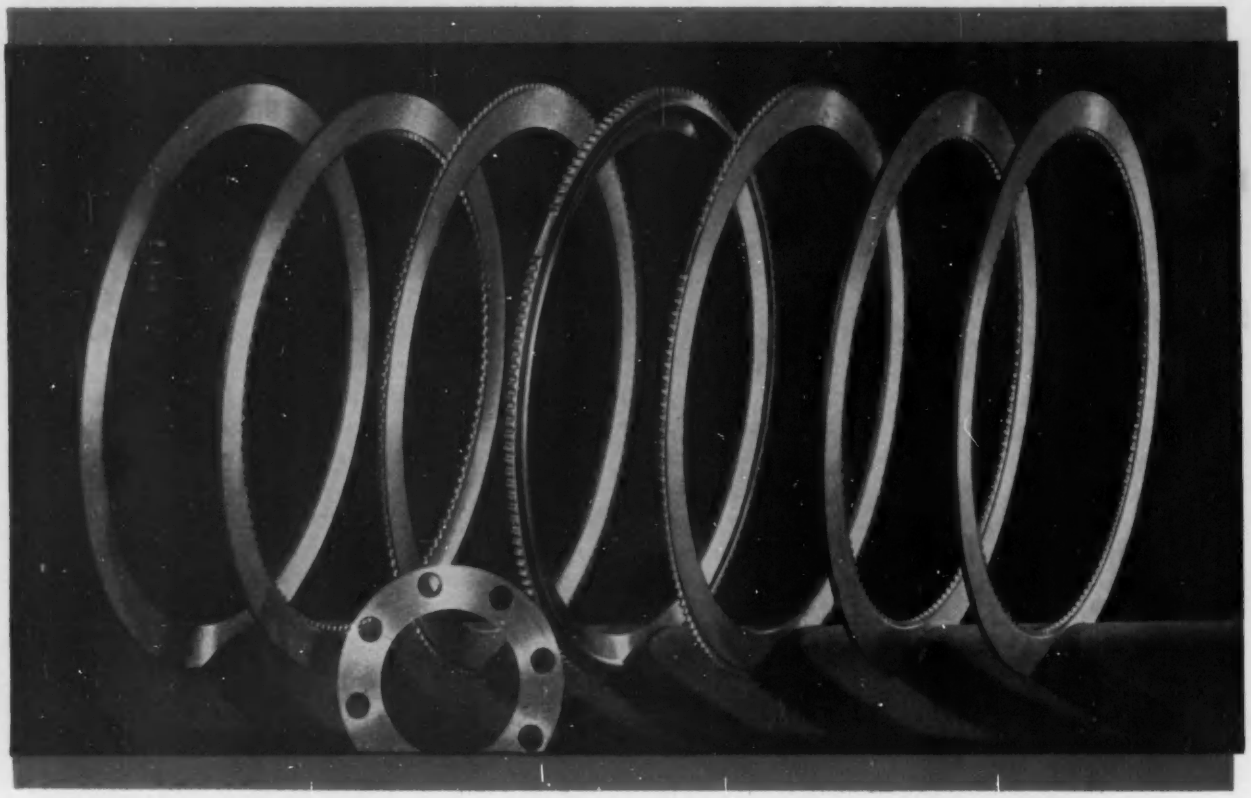


USS

USS American Quality Springs

UNITED STATES STEEL

CALL ON R/M ENGINEERING SERVICE



PERHAPS A SINTERED METAL PART IS WHAT YOU NEED

The sintered metal parts shown above suggest the scope of quality products R/M craftsmanship can produce for highly specialized applications. They are the discs, plates, retainers and spacers used in the supercharger clutch of the sensational Turbo Compound airplane engine. Do you have a friction material application that requires close tolerances or an operating condition that calls for immersion in oil? If so, R/M can provide you with sintered metal parts engineered to your specific needs.

Whatever your friction material problem, you can count on Raybestos-Manhattan for impartial advice. For R/M works in both the asbestos and the metal fields. It can meet your requirements for woven and molded asbestos and semi-metallic materials, as well as for sintered metal. If you are developing or making equipment that calls for any of these materials, take advantage of R/M's specialized engineering service. Get the full use of R/M's experience, skills and facilities. Write for R/M Bulletin No. 500. It's just off the press and its 44 pages are crammed full of practical design and engineering data on R/M's friction materials.

For booklet shown, or other data, write, phone or wire:

EQUIPMENT SALES DIVISION
Raybestos-Manhattan, Inc.
6010 Northwest Highway
Chicago 31, Ill.
ROdney 3-2400

R/M

SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL, ENGINEERED PLASTICS

Brake Blocks, Linings and Clutch Facings

Fan Belts and Radiator Hose

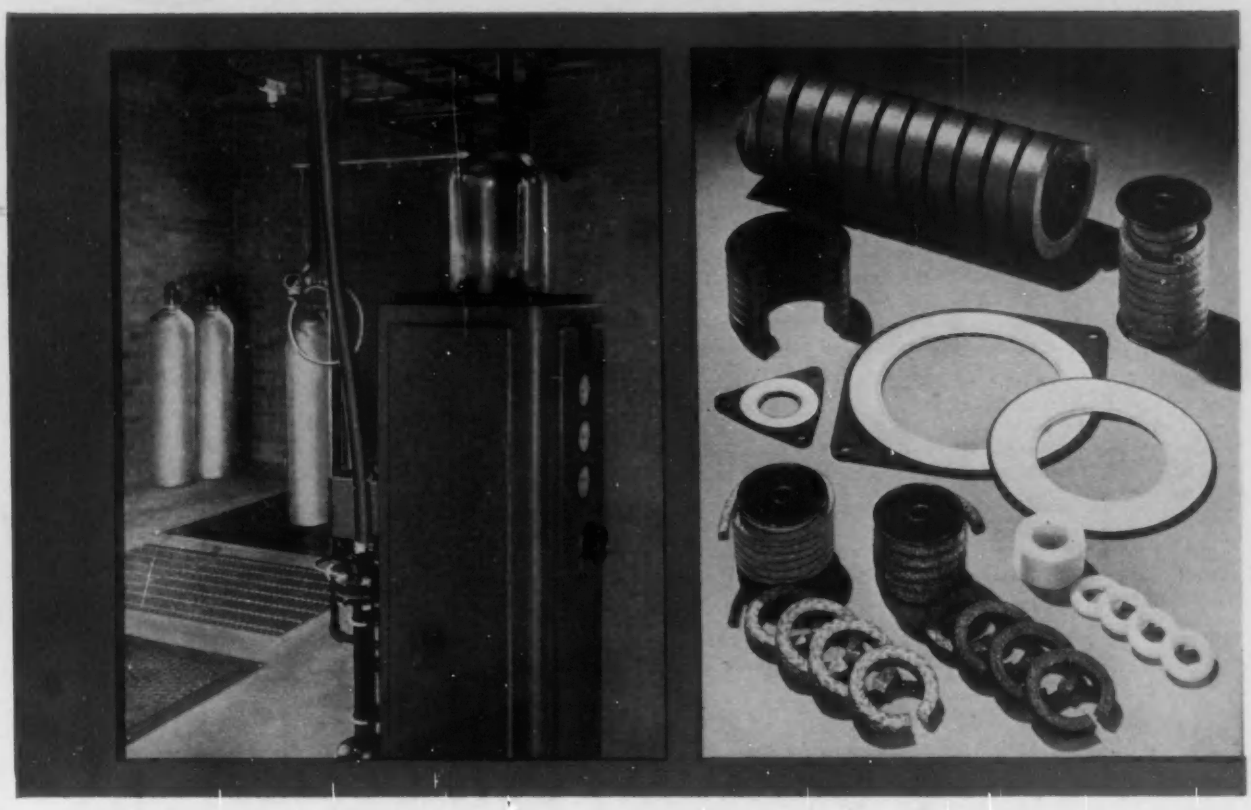
Mechanical Packings and Gaskets

Abrasive and Diamond Wheels

Industrial Drive Belts

Industrial and Automotive Hose

FOR HELP IN SOLVING YOUR PROBLEMS



R/M HOSE FOR EVERY USE

R/M makes hose for every design application to solve your problems efficiently and economically. Special constructions for acids, chlorine (like above), oil, steam, sandblast, chemicals . . . exclusive types like Homoflex Hose, light, easy-to-handle, for air, water, paint spray and other general uses. Chances are an R/M hose has already been designed that will exactly meet your design requirements. If not, R/M will custom-design the hose that does! And, of course, you can always depend on Manhattan to help solve your problems on transmission and conveyor belts, V-belts and R/M engineered molded rubber products.

(Photo Courtesy Wallace & Tiernan)

For booklet shown, or other data, write, phone or wire:

MANHATTAN RUBBER DIVISION
Raybestos-Manhattan, Inc.
Passaic, N.J.
GRegory 3-2000

PACKINGS, GASKETS, Asbestos Textiles and "TEFLON"* products

Pictured above are a few of the carefully engineered packings and gaskets Raybestos-Manhattan makes. The complete R/M line includes packings and gasket sheets for use against air, gas, water, steam, oil, chemicals, solvents, food products and hydraulic fluids. R/M also makes a wide variety of "TEFLON" products and an unusual number of asbestos textiles. If you have problems involving any of these materials or products, feel free to call on R/M's specialized engineering service. For complete information, send for booklet on packings, gaskets, and "TEFLON" products.

**Du Pont's trade-mark for its tetrafluoroethylene resin*

For booklet shown, or other data, write, phone or wire:

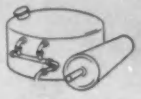
PACKING DIVISION OR ASBESTOS TEXTILE DIVISION
Raybestos-Manhattan, Inc.
Manheim, Pa.
Manheim 5-2211

RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Neenah, Wis. • Manheim, Pa. • No. Charleston, S.C. • Crawfordsville, Ind. • Peterborough, Ontario, Canada

RM

Conveyor Belts


Rubber Lined and Covered Equipment

Sintered Metal Friction Elements

Asbestos Textiles

Teflon Tape, Packings, Sheets, Rods, Tubes

Engineered Molded Rubber and Plastics

the best way we can say...

Over 2,000 of you have written to us since the Annual HANDBOOK of Product Design for 1954 reached you. Nothing you could have done would please us more, and the interest in these HANDBOOKS, of which your letters are indicative, is a spur to our efforts to make each new yearly issue better than the last. Your interest is helping us to do just that, and all of your constructive suggestions are under careful study now. You will see the results in the 1955 HANDBOOK . . . and in the meantime "thanks again" for the kind of comments we've reproduced below.

•

The Annual HANDBOOK of Product Design is an invaluable source of information. My copy is being shared by several associates and their reactions are all very favorable.

•

The 1954 HANDBOOK is excellent both in the wealth and diversity of material presented. The wide range of advertising also makes it valuable as a reference for materials and products.

In my opinion *Product Engineering* is the finest all around technical publication in America today. The 1954 HANDBOOK is excellent in all aspects.

•

In the nine years I have subscribed to your magazine, (which I consider the best by far in its field) the 1954 HANDBOOK comes closest to the design engineer's ideal for a reference of this sort.

•

I like your HANDBOOK. I like everything about it. In particular I like the advertisements because sources of supply are always important to me.

•

I'm almost afraid to admit that I am getting a great deal for my money, what with 12 copies of *Product Engineering*, topped with this HANDBOOK. At first I handled the book somewhat gingerly because I did not care to shorten its life; but there was no need for alarm since it is a pretty rugged piece of bookbinding.

is to bring you an even better

. . . and it's coming in October with all the present features you like: thumb indexing . . . sewn binding . . . detailed advertising indexes . . . 10 big sections . . . a cumulative three-issue editorial index

plus:

<u>new</u> features you say you'd like to have . . . and a wealth of new data on better ways to better product engineering

watch for further details in future issues of

Product Engineering

..."THANKS" to you for this

Thanks for a HANDBOOK so well balanced. I consider the advertising pages an extra article.

•

We think the *Product Engineering* HANDBOOK is superb.

•

Have had occasion to frequently refer to the HANDBOOK and see little room for improvement except to suggest reference to previous HANDBOOKS be maintained. Feel the sectional advertising good for "running down" a problem in new development.

•

We like this HANDBOOK very much, and it has been used to good advantage, especially a few weeks ago when we were looking for addresses of companies manufacturing friction clutches.

•

My copy is "well borrowed," and is now slightly dog-eared due to heavy use.

Just one of these HANDBOOKS alone, I think, is worth many times the subscription rate to *Product Engineering*.

•

We use the HANDBOOK often and find it invaluable. As our work is diversified, its broad coverage makes it especially useful.

•

This is the best organized HANDBOOK I have ever looked at. The cross-reference effect of your index is a supreme use of good planning.

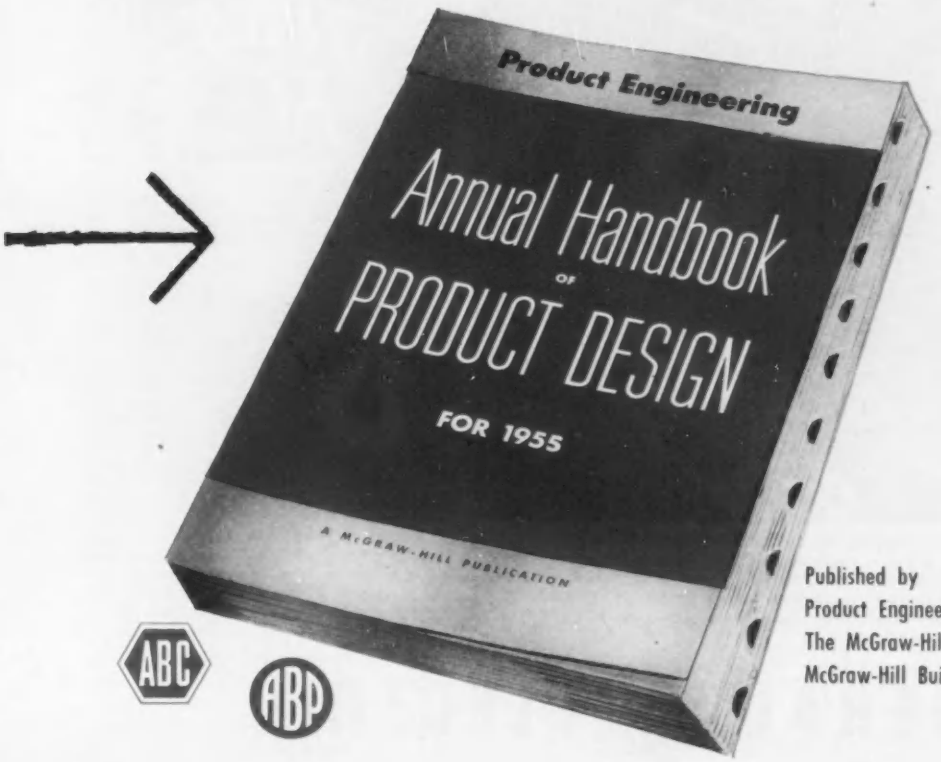
•

I don't see how you could improve it. Just the ads are an education by themselves.

•

As an Ordnance Corps officer, I have found your Annual HANDBOOKS invaluable. All issues of *Product Engineering*, and both copies of your Annual HANDBOOK, are circulated throughout our entire engineering branch.

HANDBOOK for 1955



Published by
Product Engineering
The McGraw-Hill Magazine of Design Engineering
McGraw-Hill Building, New York 36

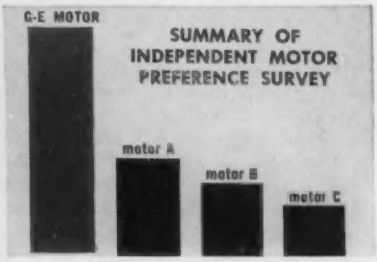
Designer's

Three good reasons for designing new TRI 55 CLAD motors into your machines

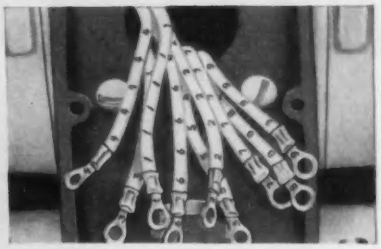
REG. U.S. PAT. OFF.

MODERNIZE YOUR EQUIPMENT with all-new General Electric Tri/Clad* '55' motors. A complete line assures you of getting the right electrical drive for your machine. Ratings in new NEMA 182 and 184 frames now available . . . entire line to 30 hp available soon. Check coupon for more information on Tri/Clad '55' dripproof, enclosed, and gear-motors.

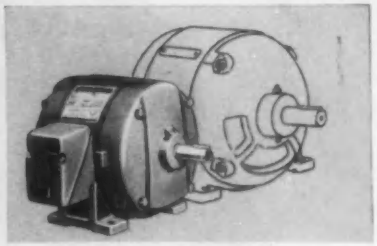
*Registered trade-mark of General Electric Co.



1. BUYER PREFERENCE. You take advantage of a 2 to 1 preference for the motors on your equipment when you use G-E motors. Buyers also like the G-E small motor service station plan (Bulletin GEC-972).



2. EASIER INSTALLATION. Perma-numbered leads are always easily read even when taped or clipped. Roomier conduit box has plenty of knuckle room. Bolts go in easily, quickly.

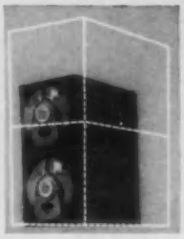


3. MORE POWER PER POUND. Lighter, smaller Tri/Clad "55" motor—in new NEMA frame sizes and ratings—reduces waste space, saves weight, lowers your handling, shipping costs.

GENERAL ELECTRIC

Digest

PRODUCT HIGHLIGHTS

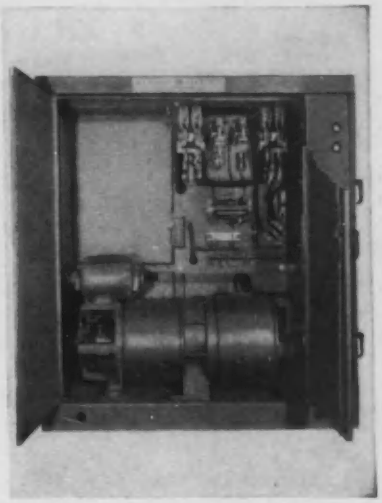


Specify G-E fhp motors to save space, material, shipping costs

G-E fhp motors give you up to 50 per cent savings in motor weight—cut down your shipping costs. Lighter weight means you can use structurally lighter mountings, save on mounting material. Some ratings save you as much as 40 per cent in space required for stocking motors, permit better use of valuable warehouse space and reduce material-handling costs. Your assembly-line people will find G-E fhp motors easier to handle, far faster to install. There's less "assembly fatigue" caused by handling heavy components. See Bulletin GEA-5567.

G.E. announces new Speed Variator designed to meet JIC standards

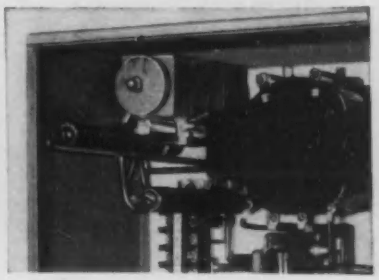
This new G-E Speed Variator is a packaged all-electric adjustable-voltage drive operating from a-c power, for use where conformity to JIC standards is required. It gives you highly efficient operation over wide speed ranges from 8 to 1, up to 50 to 1. Components are: a power unit in attractive cabinet, containing motor-generator set and all necessary control; d-c motor; operator's remote control station. New JIC features include: positive-pressure ventilating system which keeps out dust; metal diagram pocket on inside of enclosure; doors mechanically interlocked with disconnect switch for safety; rigid all-steel enclosure; color-coded wiring; a-c control isolated from d-c control; a fusible disconnect switch to isolate unit from power source; and lockable disconnect switch on door. Write for Bulletin GEA-6000.



Get high repetitive accuracy with G-E electronic timers

Precise timing, adjustable from 0.06 to 120 seconds for important machine functions, is yours with G-E timers. Repetitive accuracy is within ±2% of dial setting, independent of normal temperature changes. Can be used for immediate or delayed start. Timing dial may be remotely mounted for easy adjustment. Ask for Bulletin GEA-5255.

Metallic rectifiers help make machine tools more productive



Metallic rectifiers, such as the selenium stack (right), used to supply d-c power for magnetic clutches and brakes, have helped to increase the productivity of this lathe and other machine tools. Many control circuits use these rectifiers to power d-c relays. Let G-E selenium, copper-oxide, and germanium rectifiers help you in designing more productive machine tools. Check coupon for bulletins.

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- ☐ GEA-5699 Copper-oxide Rectifier Stacks
- ☐ GET-2350 Selenium Rectifier Manual
- ☐ GEA-5773 Industrial Germanium Rectifiers
- ☐ GEA-5255 Electronic Timers

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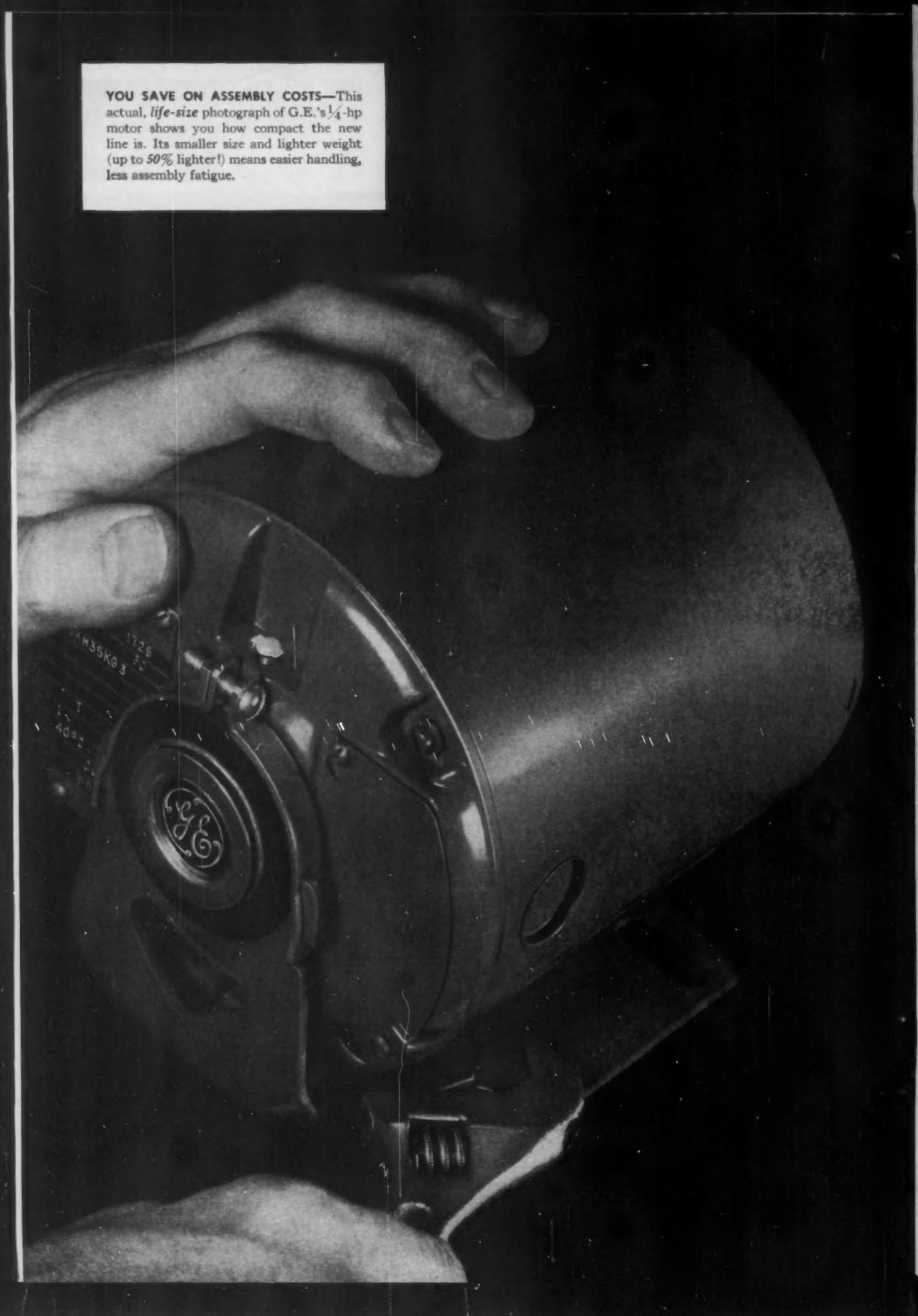
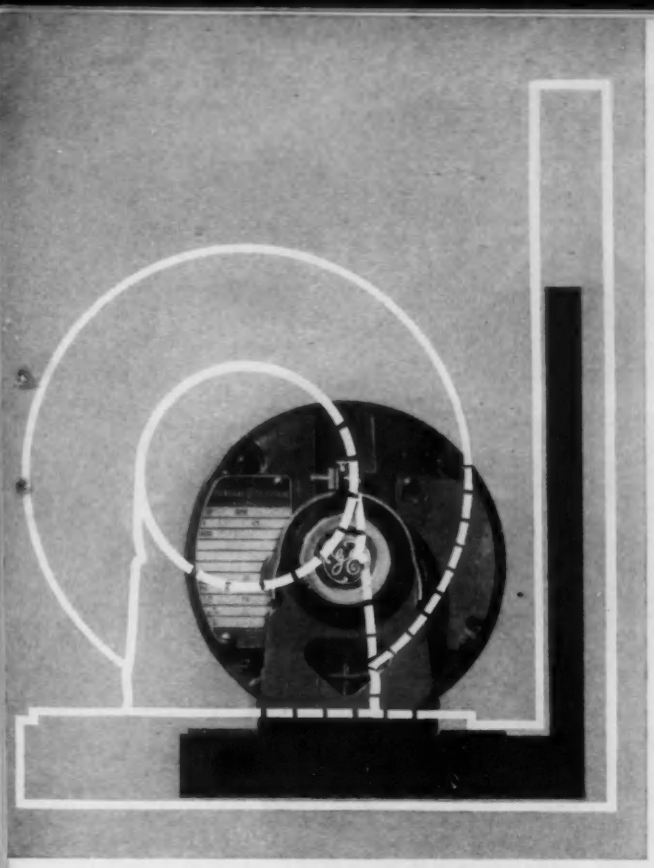

YOU SAVE ON ASSEMBLY COSTS—This actual, *life-size* photograph of G.E.'s ¼-hp motor shows you how compact the new line is. Its smaller size and lighter weight (up to *50%* lighter!) means easier handling, less assembly fatigue.



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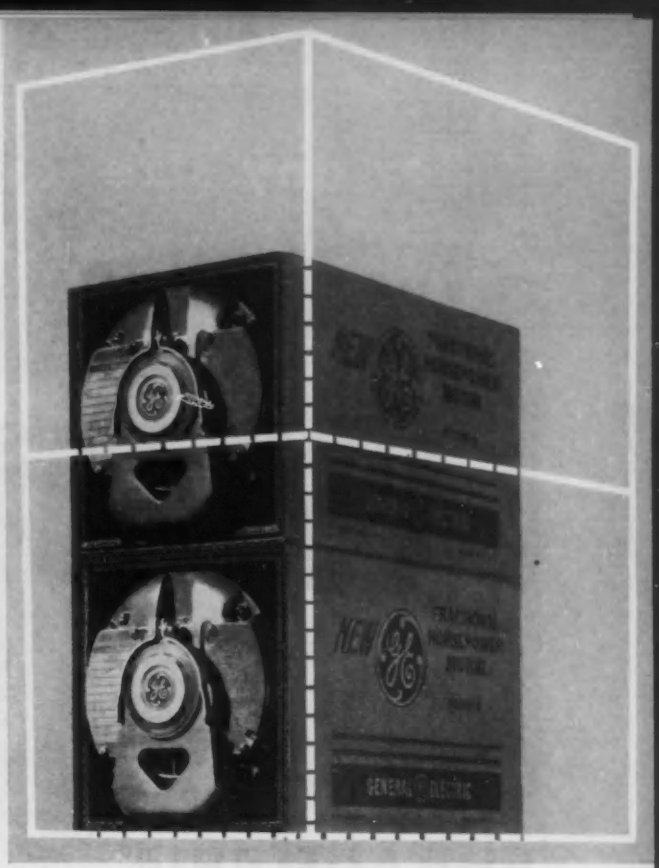

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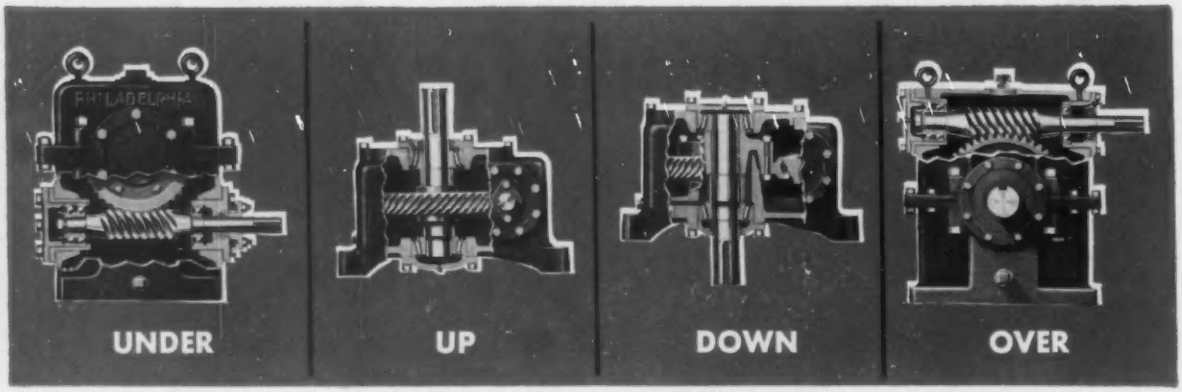

Type "AT" Philadelphia Heavy Duty Worm Gear Reducer, with worm shaft *below* the worm gear.

Type "UT" Heavy Duty, Vertical Worm Gear Reducer, with slow speed shaft extended upward.

Type "VT" Heavy Duty, Vertical Worm Gear Reducer, with slow speed shaft extending downward. (Note "dry-well" construction around downward shaft.)

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Perspectives — DESIGN AND DEVELOPMENT

CORPORATIONS LOSE AGAIN

For the second time in two years, the concerted efforts of a group of major engineering corporations to amend the New York State engineering license law have been rebuffed. Their opposition, the same as before, was the New York State Society of Professional Engineers (NYSSPE). The objective of the corporations—the present group operating under the title of Committee on Engineering laws (CEL)—was to change the law to permit general corporate practice of engineering. The bill did not reach the Senate for a vote, but it has gained momentum, as evidenced by the 34 corporations pushing it. The previous attempt recruited only seven.

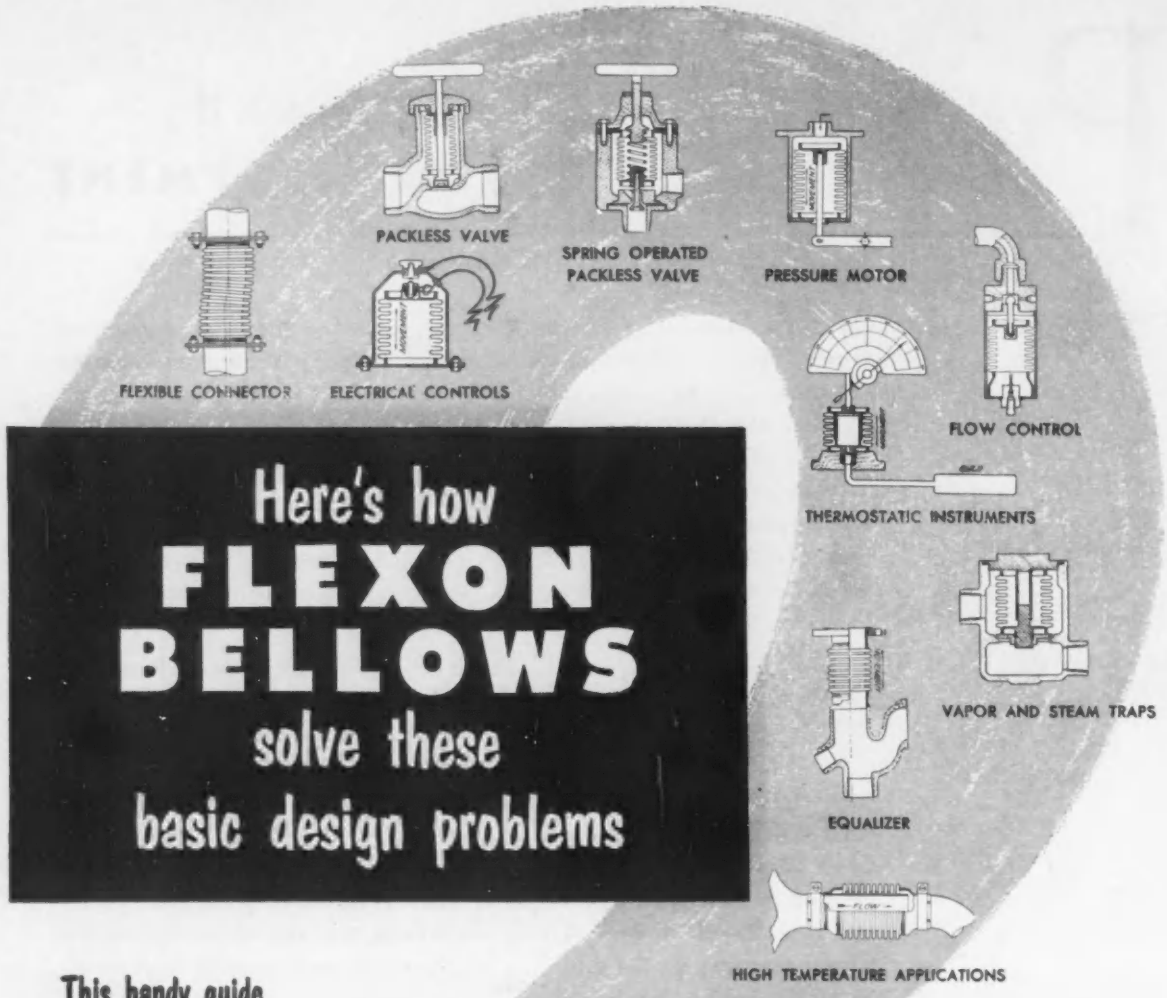
AS IT STANDS NOW

This law, a section of the New York Education Law, dates back to April 15, 1935 and prevents a corporation from practicing professional engineering unless: it was incorporated in New York State, and was practicing on and continued to practice after April 15, 1935; and then only if the chief executive officer and the persons actually practicing professional engineering were licensed professional engineers. (Three other states—Ohio, Rhode Island, and Washington go along with New York in prohibiting the practice of professional engineering by corporations. Thirty-one states permit it, with varying restrictions, and the remaining thirteen have no statutes on the subject at all; however, such practice is generally allowed.) Oddly enough, under this law a corporation may not be formed if its only purpose is to design machinery or apparatus "where the safeguarding of life, health, or property is concerned." But, the same corporation may be formed to design *and* construct machinery or apparatus under the same requirements. So, a corporation which does nothing but design is outlawed; but a corporation that designs *and* constructs can legally exist.

PROPOSED NEW LAW

The amendment as proposed by CEL, and introduced in the 1954 State Legislature as the Carlino-Milmoe Bill, listed safety measures that would make the corporations subject to the same penalties as individual registered engineers, or members of partnerships. Further, a corporation practicing engineering had to have an officer of at least the rank of vice president who is a registered professional engineer in charge of the engineering activities. An added requirement was that all other employees in responsible positions in the engineering department should be registered. The corporations must register at least biennially, listing at that time the names and addresses of the persons controlling the corporation directly or indirectly, and the names, addresses, and professional license numbers of the responsible engineering officers.

(Continued on page 125)



Here's how FLEXON BELLOWS solve these basic design problems

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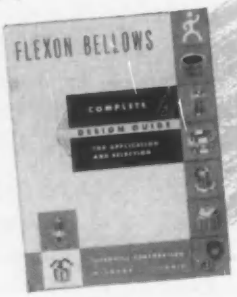

In any product that requires a motion controlled by temperature, or where a shaft or similar part must be sealed without packing, Flexon Bellows will answer the problem—and assure quality performance.

Flexon Bellows are manufactured by advanced methods to combine economy with exceptionally high standards of uniformity. They are available in brass, bronze or stainless steel in a complete range of sizes to meet virtually any need. For unusual applications, Flexonics bellows engineering specialists will be pleased to assist you. For quotations or recommendations, just send an outline of your requirements.

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Flexon identifies products of Flexonics Corporation that have served industry for over 52 years.

NYSSPE VIEW

The NYSSPE did not go along with this, claiming: "Our engineering profession, composed of highly trained, experienced and ethical practitioners, would be reduced to the status of a mere trade.—The individual engineer would be either eliminated or reduced to a mere paid employee of these "big business" corporations—Individual initiative and competence would be destroyed in the engineering profession, which in the design and supervision of construction is responsible for safeguarding the public welfare." And: "Untrained and perhaps unscrupulous persons, not Professional Engineers, could organize dummy corporations and effectively practice professional engineering through the "cover" of a licensed engineer dominated and controlled by them.—It would undermine all of the learned professions (medicine, law)." Finally: "It would be both expensive and difficult, if not impossible, to enforce the engineering law against corporate violators."

CEL DIFFERS

The CEL wants to know, "What is so evil or undignified about the corporate form of business?" With the proposed amendment, corporations will be subject to the same laws as individual engineers. Even so, the corporate form of business does not relieve the responsible professional engineers—officers or employees—of the liability for malpractice. And, there is much proof existing today that professional engineering has been carried out safely and competently for a number of years. The large corporations would not be in evidence today if this were not the case. Furthermore, the great majority of engineers today are in their employ. In view of the limited capital accumulation that is allowed, and because of the tax set-up, corporations are the only form of business organization able to keep funds that can be directed to research and the development of new ideas. To operate on such a scale, it is necessary that men qualified in administrative, finance, and personnel be added. But under the present law such men could not be added to a partnership unless they happened to be registered professional engineers. Furthermore, because of the present tax laws, it is impossible for a partnership to build up sufficient reserves for pension and retirement funds.

ONE OPINION

As Mr. A. G. Stanford, former president of The National Society of Professional Engineers, and past president of The National Council of State Boards of Engineering Examiners, so aptly stated his views: "I am heartily in favor of the requirement that those individuals in any partnership or corporation who are in responsible charge of design work should be registered; and it is also desirable, from a professional standpoint, that as many others who are qualified and who work on design projects to likewise be registered. I feel confident that it is possible to frame our registration laws to permit the practice of professional engineering by corporations without unduly jeopardizing the safety and life of the public. I urge a realistic approach and a careful consideration of the overall problem by those of our Member State Boards faced with any problem relative to changes in the registration law."

TINNERMAN

Speed Nut Savings Stories

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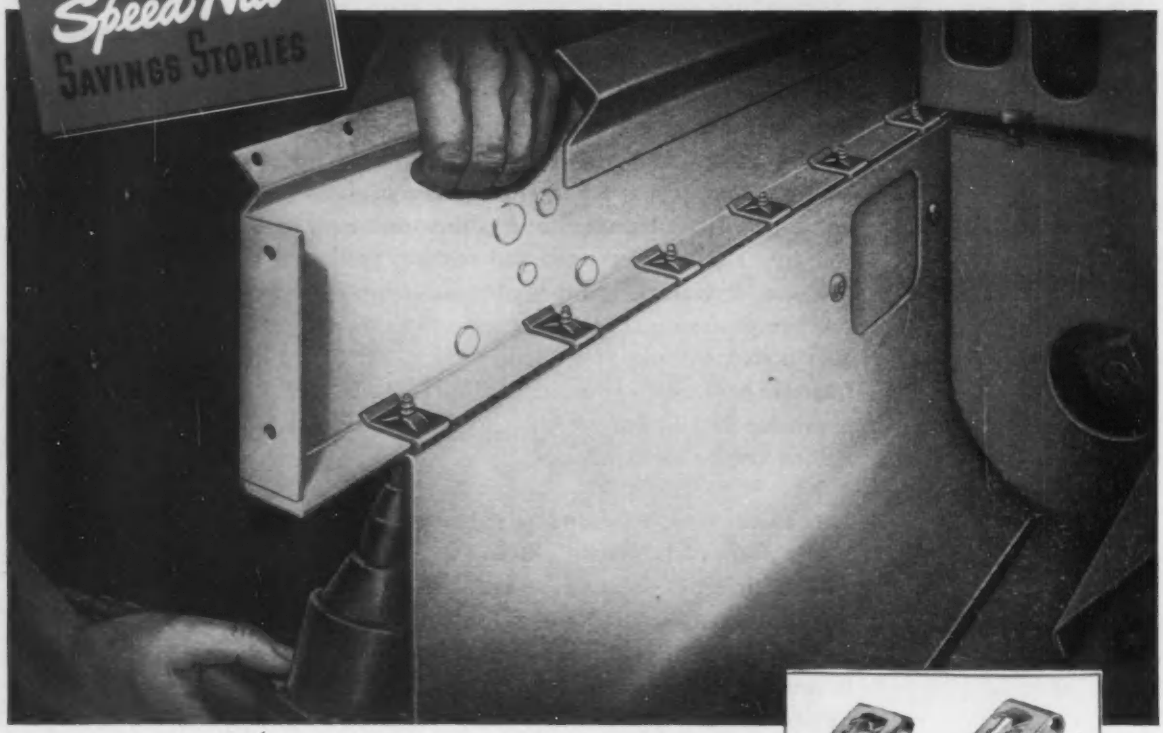
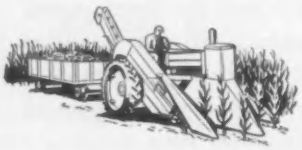


JOHN DEERE harvests 3-way savings!



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Horns Blowing in the Fog

IN THE CONDENSATION OF AN ARTICLE that had appeared in a national magazine of several million circulation, appears the statement ". . . . there is a growing emphasis today on the broad individual rather than the specialist. This concept has led some companies to re-examine the generations-old practice of hiring mostly technically trained people—engineers, chemists, accountants, graduates of schools of business administration. . . . (They now find that the man) who understands history, literature and philosophy . . . has the type of mind that will ultimately succeed."

The author of the article implies that industry has concluded it must look to arts school graduates, students of history, literature and philosophy, for executives to operate American industries in the future. Presumably that is what the author believes. It sounds like a lost mariner blowing his horn in a fog.

A glance at the record shows that engineers predominate in the list of top executives of the leading industrial corporations. If the industrial corporations directed by engineers were to go out of business, the world would take a long stride back toward the dark ages.

Here are a few of the innumerable companies headed by engineers. The world's largest corporation is the American Telephone and Telegraph Company. Its president is Cleo F. Craig, E.E., University of Missouri. Considerably more than half the A. T. and T. officers responsible for plants or operations are engineering graduates.

Until he went to Washington to administer the great military procurement program, Charles E. Wilson, E.E., Carnegie Tech., was president of General Motors Corporation, the world's largest manufacturing organization.

Without steel, most manufacturing companies would have to shut down. Clifford F. Hood, B.S. in M.E. from University of Illinois, is president of the U. S. Steel Corporation; Eugene Grace, E.E., and Tom Girdler, M.E., both from Lehigh University, chairman of the board of Bethlehem Steel and Republic Steel respectively. More than 80 percent of the steel produced is made by companies directed by graduate engineers.

The world's largest oil company, Standard Oil Company of New Jersey, recently made M. J. Rathbone, chemical engineer from Lehigh University, its president. And Crawford Hallock Greenewalt, Ch. E. from M.I.T., is president of du Pont.

The list is almost endless. Year by year the science and technology involved in the operation of industries is becoming more complicated, more exacting. Only scientists and engineers can tackle the problems intelligently.

It is not surprising that a journalist should be unaware of the essential part played by engineers in the direction and operation of industries. Not many engineers are fully aware of it. But the arts school graduates who claim that their training makes them the ones best fitted to run industry are merely blowing their horn in a fog created by ignorance.

George F. Bardenheier

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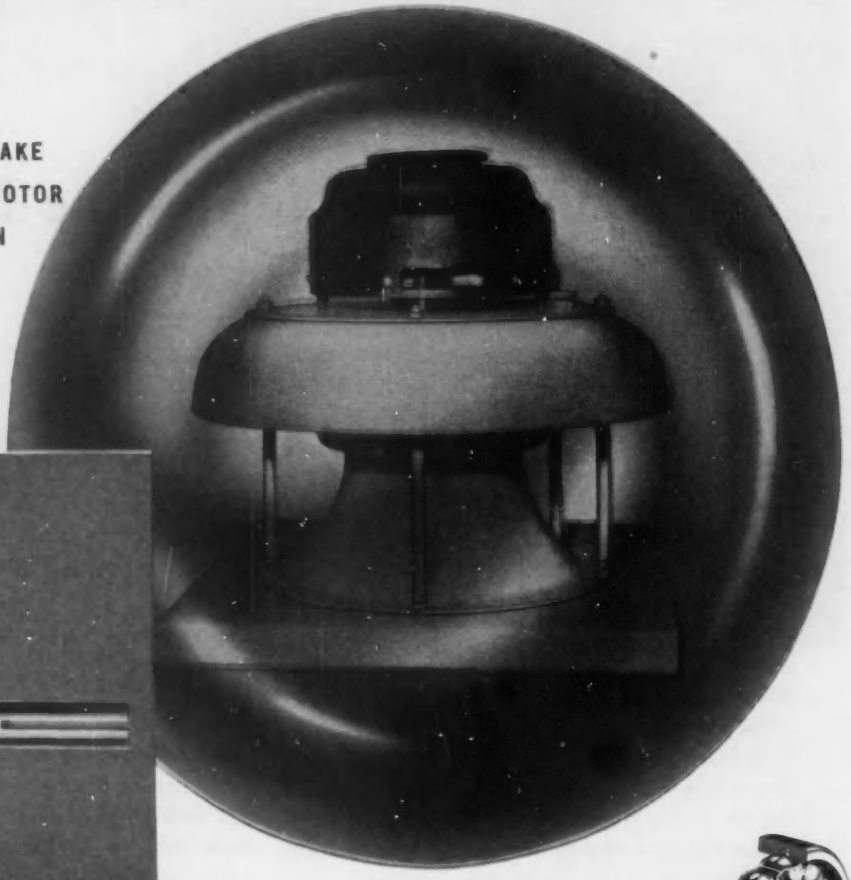

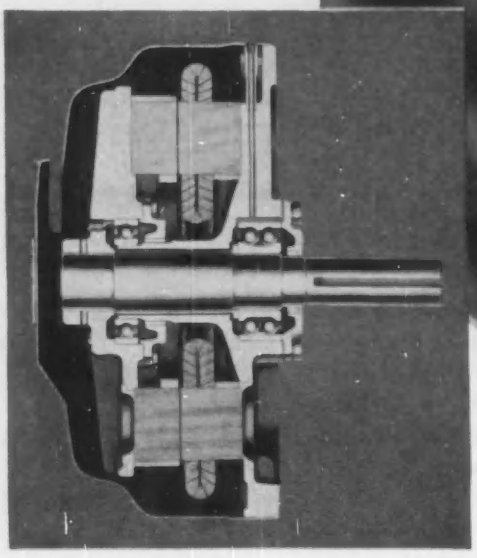

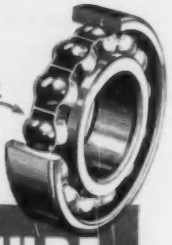

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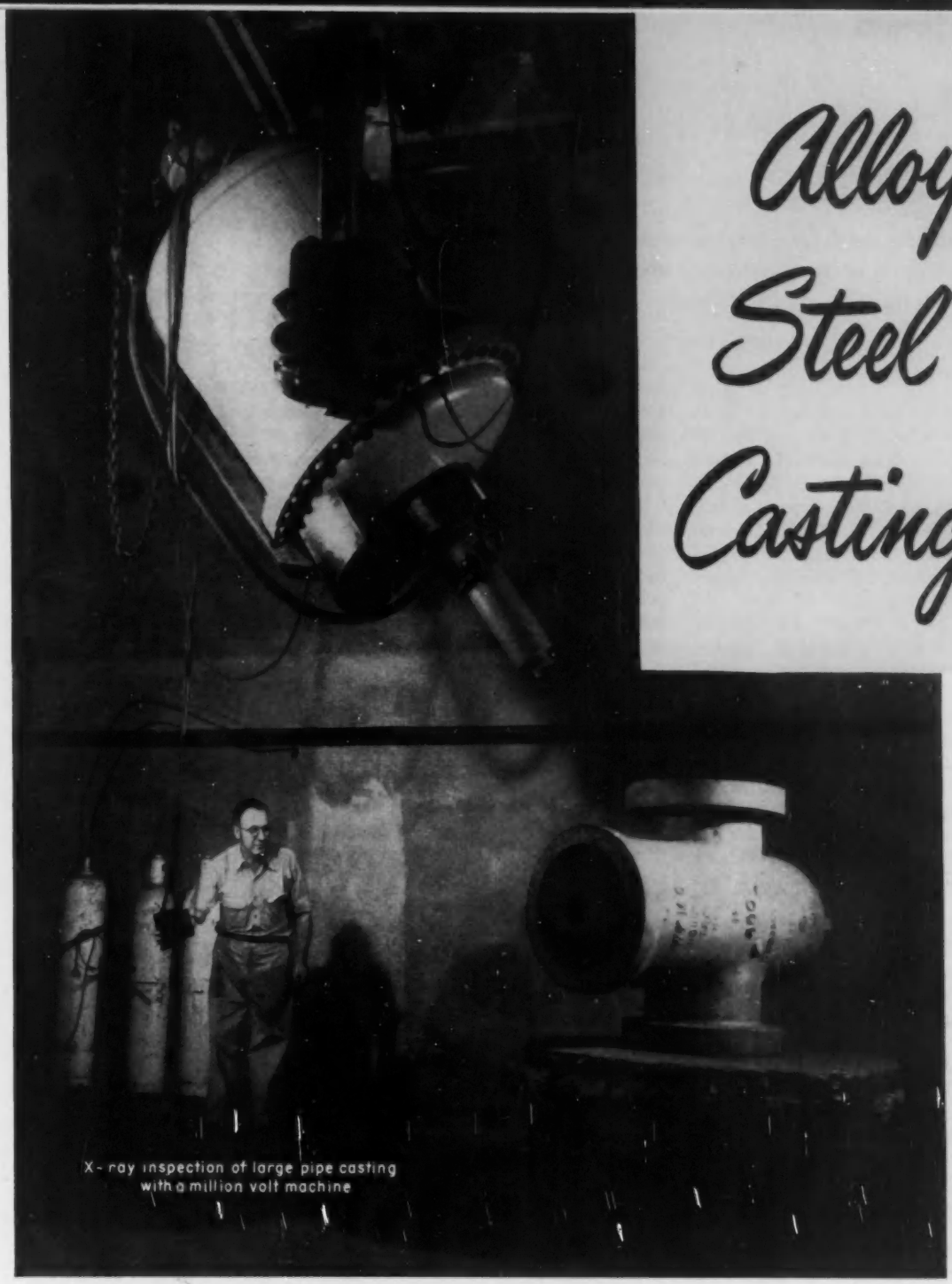
Alloy Steel Castings



X-ray inspection of large pipe casting with a million volt machine

JOHN M. QUINN, ASSISTANT PLANT MANAGER, LEBANON STEEL FOUNDRY

ADVANCED SCIENTIFIC RESEARCH and control in producing steel and alloy steel castings have to a marked extent replaced the old rule of thumb methods. Intricate shapes that would have been considered entirely impossible a generation ago are now being cast with daily regularity. Service conditions practically unheard of in the last decade have been made possible through the development and application of steel castings.

However, to get the highest quality at a reasonable cost, consultation with the foundry metallurgist is desired before final designs are adopted. Quality castings can be made efficiently and economically only when the casting designer and foundry engineers cooperate in a joint effort to achieve the desired final result.

SUPERIOR AND ECONOMICAL steel castings can be produced only by the integration of correct stress analysis, the observance of metallurgical essentials, the use of properly designed patterns and the application of sound pouring procedures, inspection techniques in foundry.

When a mechanical engineer is designing a machine element he determines the loads that will be imposed on the casting, such as temperatures, pressures and operating conditions. Sometimes additional requirements must be met, such as resistance to shock or impact, limited deflections, weight limitations, corrosion resistance, and other critical factors. The designer will sketch the part, giving general overall dimensions, important detail dimensions that must be adhered to, surfaces that must be machined, and other similar features.

It is at this early stage of the design that the foundry metallurgists and engineers should be called in. The next step is the decision as to the type of steel or alloy steel to be used. Here the problem may involve compromising to get the optimum combination of strength, ductility, ability to withstand high temperatures, erosion resistance, and other properties, whatever the service requires.

Often the problem of deciding on the exact alloy to use is further complicated by the necessity of heat-treating it. This applies when it is necessary to develop high physical values within the capabilities of the alloy selected. Normalizing, tempering or annealing heat treatments rarely constitute a problem. High strength levels are usually accomplished by hardening and tempering operations. Some casting designs can be successfully quenched in either oil or water without difficulty. Other more complicated designs cannot be successfully hardened without danger of quench cracks or excessive warpage caused principally by dilation and strain.

Obviously, if the part must be quenched drastically it might be necessary to distribute the metal, avoiding abrupt section change so that the differential shrinkage upon quenching will have no deleterious effect. This will dictate the relative locations of heavy sections, thin walls and bosses. The original shape might have to be modified considerably in order to incorporate these features.

Another important consideration that dictates the distribution of the metal is the volumetric shrinkage of the metal during solidification after pouring. As the molten metal solidifies, its volume decreases. The shape of the piece must make it possible for molten metal to feed into those sections where the volumetric shrinkage is taking place. The purpose of risers, reservoirs of molten metal, is to do exactly that. However, it is also necessary that the shape of the piece and the relative positions of thick and thin sections to be such that the feeding of molten metal will progressively take place as required. Sometimes wall thicknesses must be tapered to assure this result.

It may be that certain sections of the casting will be highly stressed, whereas other sections will carry practically no load. The efforts of the foundry will be directed to assuring maximum density of metal in the highly stressed regions, sometimes at the sacrifice of the density of the metal in the sections that carry less load.

Different alloys have different fluidity at pouring temperatures but these variations usually can be taken care of by gating the mold accordingly. However, differences in fluidity might possibly permit or require some detail changes in the design of the part. Although this occurs only rarely, it does further emphasize the essentiality of the designer consulting the foundry at the proper point in designing.

The design of the part must be such that the drafts will be correct, cores and core prints properly placed and anchored, and that there will be a minimum danger of sand washes, cold shuts and similar defects. Many of these requirements are controlled by the design of both the part and the pattern, the design of the latter also being largely affected by the methods used in the foundry. The location of the parting line or surface will of itself dictate many of the details of the design of the pattern. It will often determine whether or not green sand cores should be used.

The number of cores used should be a minimum. Often patterns with loose pieces can be used in place of cores.

DISTORTION on cooling or heat-treating is not necessarily serious. Often the casting can subsequently be straightened, as is being done here in a power press. But it is more economical to avoid distortion.

Many times a pattern maker specifies cores where it would be more feasible and economical to machine the hole or cavity. The position of the core prints or anchors for the cores can be determined best only by the foundry. It is too easy, for the designer to place a core in a position where it would shut off or interfere with the feeding of metal during solidification.

Obviously, innumerable difficulties that might arise because of improper pattern design can be avoided by having the foundry construct the pattern. Indeed, only the foundry, using the data furnished by the customer, can specify the type of pattern that will be most economical. Whether the pattern should be of soft wood, hard wood, hardwood with a metal lining or metal can be determined intelligently only by the foundry. It is not only the number of castings to be made that determines which kind of pattern to make. A soft wood pattern might suffice to make a few hundred pieces of a simple shape, whereas another part might require a hard wood pattern even to make only a relatively few pieces. Only the foundry can decide.

Many books and articles have been written on the design of castings. It cannot be expected that every conceivable design requirement, every possible condition, every difficulty and every technique can be covered fully in the literature. Casting is both an art and a science. As an example, most articles on casting design emphasize, and properly so, the desire for uniformly thick sections. For the conventional commercial casting that does not have to meet the highest qualities, the theory of uniform thickness is commercially acceptable. However, for the lightest casting, for the most solid casting, and for a casting of maximum strength, it is essential that the wall sections shall be of tapering thickness.

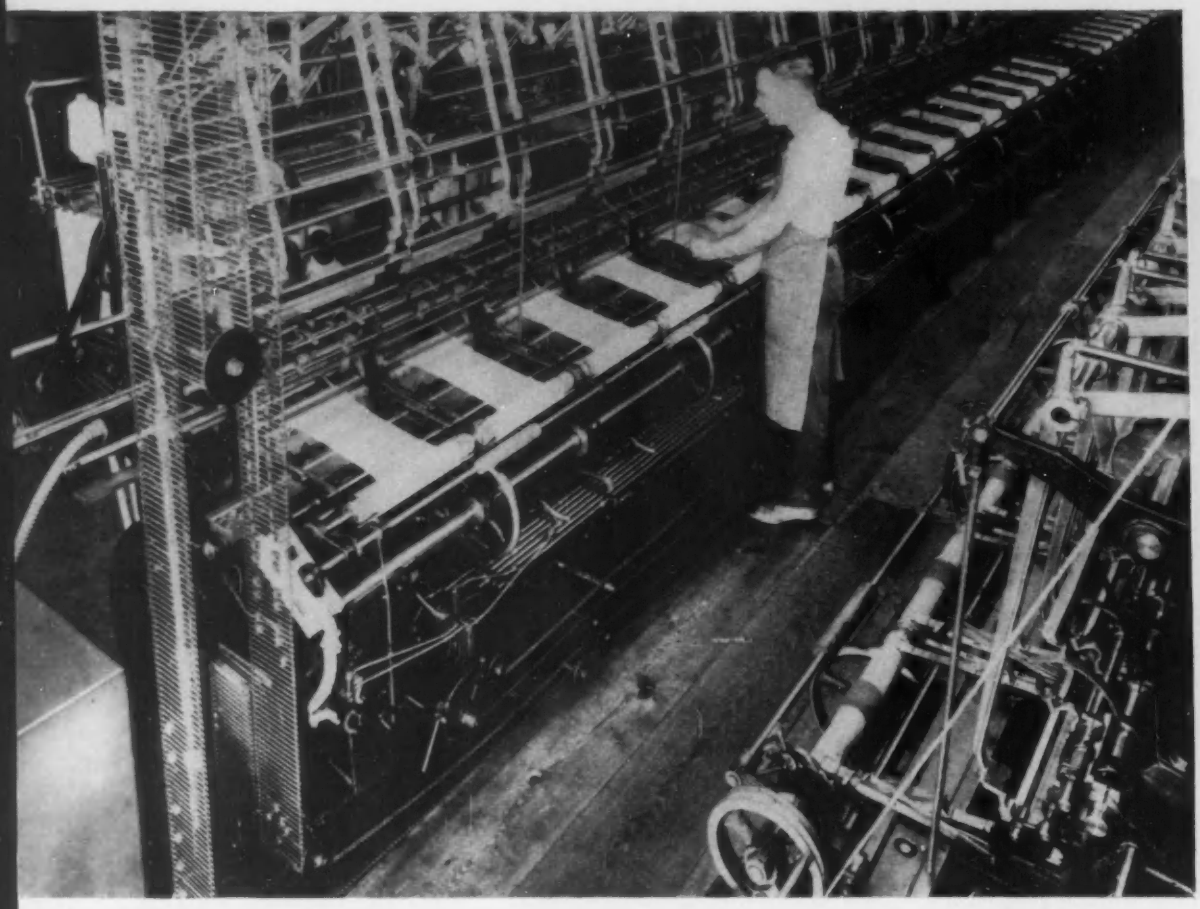
A good procedure in developing the design and specifications for a casting is to make a sample and subject it to experimental stress analysis. Such an analysis will show the regions of high stress and the areas in which the stresses are below nominal. This will then permit the designer to check against his calculations and to indicate critical areas or sections of the casting that should be X-ray inspected. It may be further desirable to surface inspect castings, in addition to X-ray, by the Zyglo or the Magnaflux inspection. When a casting is subject to critical stresses such non-destructive testing is advisable, along with appropriate acceptance standards.

The end use of castings should dictate the amount of non-destructive testing, keeping within reasonable economic bounds. It is a waste of money to require complete inspections if the occasional failure of a casting will not have disastrous results. Likewise, it is a waste of money to require the X-raying of sections that are not subjected to high stresses or that need not be completely sound. Obviously, meticulous inspection is not needed for commercial quality castings that will not be called upon to carry unusual loads or contend with corrosive conditions.

As stated, this article relates entirely to the design and production of high quality castings that will be highly stressed or that will be subjected to unusual conditions, or both. The designer will always need the foundryman and the results of metallurgical research, in working out the best possible uses of materials available. Through cooperative methods the greatest technological advances in the design and production of the highest quality steel castings can be assured.

MAGNAFLUX INSPECTION of castings often is desirable if surface defects will have a deleterious effect on service life of the part.

CHECKING HARDNESS of centrifugal cast ring. Obtaining advice on alloy selection minimizes the problem of heat-treating the casting for the highest physical properties required.



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- *How drives vary for different horsepower ranges.*
- *Special motor requirements.*
- *How to integrate drive into design of driven machine.*
- *Practical considerations in typical applications.*

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THE FOREMOST FEATURE of the forced-torque type of adjustable speed machine drive is its ability to rapidly accelerate and decelerate the driven members. It is used on machines that operate most efficiently at a series of different speeds or on machines that accelerate to operating speed and immediately decelerate. Operation at the maximum optimum speed during each portion of a machine's work cycle normally results in reduced total cycle time and increased production rates. In addition, critical operations, such as when the die meets the work in a press, can be performed at a low speed with reduced material spoilage and without greatly increasing the total cycle time as would result if the drive operated at a constant speed. The use of smooth motor acceleration and re-

Fig. 1—Two typical hosiery knitting machines driven by low horsepower forced-torque drives. Unit on left actuates speed control switches by means of projections on continuous chain. The magnitude and duration of the various operating speeds can be varied to give the desired performance by adjusting the speed control potentiometers and the position of projections on the chain.

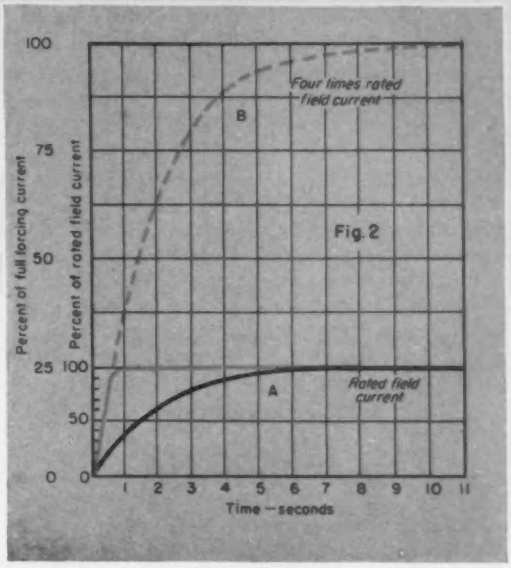


Fig. 2—Response of generator field current to the application of rated field voltage, curve *A*, and four times rated field voltage, curve *B*. Initially aiming field currrent at a high forcing level (actually limited by saturation) reduces the time required to reach rated current from about 8 or 9 sec to 0.6 sec (as shown by solid colored curve).

generative braking deceleration results in decreased shock on machine members so that the required amount of maintenance is reduced and machine life is extended.

This type of adjustable speed machine drive has replaced many conventional machine drives in applications where the conventional drive either operated at a constant speed with no attempt to obtain optimum speeds throughout the cycle or where various speeds were obtained by using a bulky unreliable mechanical system of brakes, clutches and linkages. Although there is no practical limit to the range of power output of forced-torque drives applications to date vary from 5 to 500 hp and include hosiery knitting machines, press feeders, automatic conveyors, planers and automobile body presses.

To obtain rapid speed shifting, rapid reversals, accurate stopping and well regulated speeds, high horsepower motors that are capable of delivering the large accelerating torques without failure are required together with fairly complicated control systems. Careful engineering studies should be carried out on proposed or existing machines to insure that the gain because of increased production rates, reduced spoilage or reduced maintenance is sufficient to warrant the use of this type drive (see Forced-Torque Electric Adjustable Speed Drives, *Product Engineering*, April 1954, pg 168).

The forced-torque drive operates on the Ward-Leonard principle in which the speed of the d-c driving motor is adjusted by varying the shunt field excitation of an electrically connected constant speed d-c generator. In the

usual Ward-Leonard drive the speed of response of the motor is limited by the time constant or electrical inertia of the generator field. Thus, if the time constant of a typical generator field is 2 sec (L/R ratio or time required to reach 63.2 percent of rated field current after the application of rated field voltage) and the generator field control circuit calls for a change from zero to rated current, it takes about 9 sec to reach this final value after full field voltage is applied, see Fig. 2. This elapsed time is much greater than can be tolerated if the speed of the motor is to be changed in a fraction of a second.

To improve this speed of response the field current buildup can be forced by applying more than rated field voltage. For example, curve *B* of Fig. 2 shows that rated field current can be reached in 0.6 sec by applying four times rated voltage. When the field current reaches this required value the field voltage is automatically reduced to its proper value and the drive is regulated to operate at this condition until another change in field current is required. Thus although the time constant of the field has not changed, this arrangement takes advantage of the exponential form of the response curve by initially aiming the field current at a much higher value than is finally desired. The dotted response curve above rated current can never be reached because of automatic voltage cutoff and saturation.

To use field forcing, the control circuits must respond practically instantaneously to remove the field over-voltage. For this reason, electronic regulators are used. In addition, antihunt and stabilizing circuits can be easily incorporated in this devices.

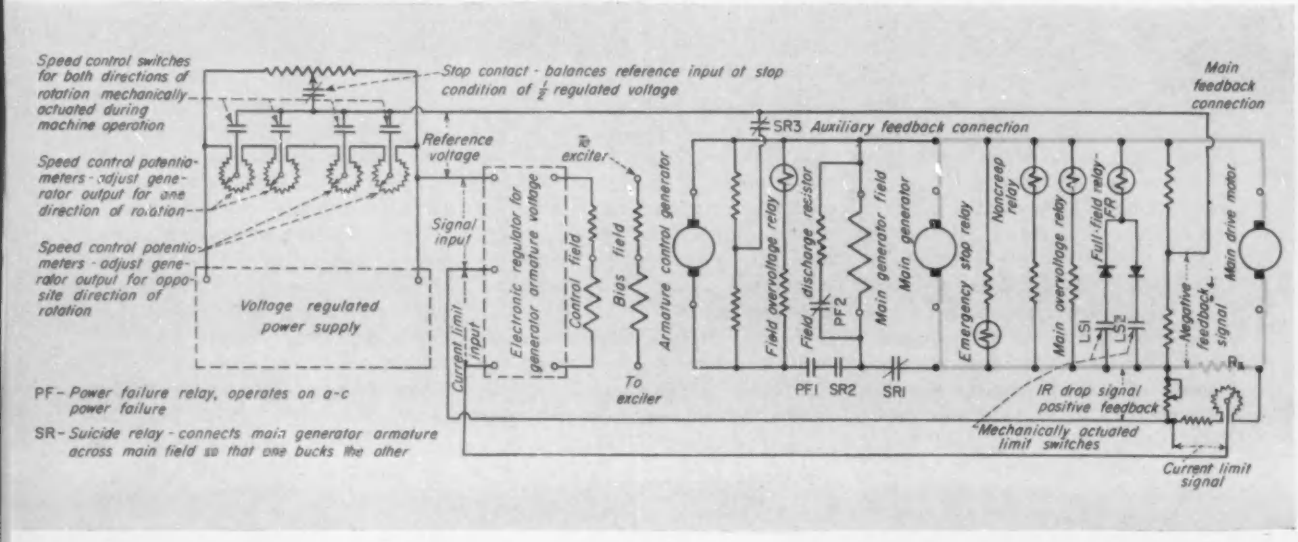
Although all forced-torque drives are basically similar, the specific circuits depend primarily on the horsepower requirements and partially on the particular machine characteristics. While the horsepower ranges are not rigidly fixed, present applications can be grouped as follows: 150 to 500 hp, 20 to 150 hp, 10 to 40 hp and 7.5 hp and smaller. Generally the high horsepower applications use the most complicated version of the drive with the lower ranges using simpler adaptations of the basic circuit.

Forced-Torque Drive Circuits

In Fig. 3 is shown a typical forced-torque drive circuit such as might be used to control a 500 hp motor. The circuit consists essentially of the following components or networks: reference inputs for armature circuits, electronic regulator for armature circuits, armature control generator, main generator, main motor armature, main motor field control generator and the electronic regulator and reference input for main motor field control. Of these components, the motor field control circuits and the control generators might bear mention before the complete circuit is discussed in detail.

In addition to obtaining adjustable speed by varying the armature voltage to the main motor, many forced-torque drives obtain higher cycle speeds by controlling the excitation of the main motor field. Variation of the shunt field of a d-c motor produces a speed range at constant horsepower, with a reduction in field excitation causing a higher speed. Although the field weakening process results in a higher speed without additional main generator capacity, it only does so at a sacrifice of motor torque available for work and for accelerating during speed changing. However, in many machine tools this can be tolerated since metal cutting is essentially a constant horsepower process with heavy cuts (high torque required) being taken at low speeds and light cuts (low torque required) being taken at high speeds. In addition, provisions are made for switching to full field conditions during drive reversals and during periods of high acceleration or deceleration.

Fig. 3—Schematic diagram of typical forced-torque drive for use in 150 to 500 hp range.


Speed control switches for both directions of rotation mechanically actuated during machine operation
Speed control potentiometers - adjust generator output for one direction of rotation
Speed control potentiometers - adjust generator output for opposite direction of rotation
Voltage regulated power supply
Stop contact - balances reference input at stop condition of ½ regulated voltage
Reference voltage
To exciter
Signal input
Current limit input
Electronic regulator for generator armature voltage
Control field
Bias field
To exciter
Armature control generator
SR3 Auxiliary feedback connection
Field overvoltage relay
Field discharge resistor
PF2
Main generator field
Main generator
Emergency stop relay
Noncreep relay
Main overvoltage relay
Full-field relay FR
LSI
LS2
Main feedback connection
Negative feedback signal
Main drive motor
Ra
PF1
SR2
SRI
IR drop signal positive feedback
Mechanically actuated limit switches
Current limit signal
PF - Power failure relay, operates on a-c power failure
SR - Suicide relay - connects main generator armature across main field so that one bucks the other

Since the motor field exhibits electrical inertia in the same manner as the main generator field, field forcing is also used in the motor field control circuit. This is again accomplished by impressing a high voltage on the winding and automatically reducing to rated field voltage when the desired field strength is achieved.

Because the forcing of the generator and motor fields requires that a voltage from 4 to 8 times rated field voltage be applied, low voltage high-current fields are used. Under this condition, it is impossible to supply this relatively high field current directly from an electronic regulator and control generators are used as an intermediate step of power amplification. These control generators are small (3 to 4 KW) so that their time constant does not contribute materially to the system time lag. They are driven by a constant speed a-c motor.

Since it is difficult to reverse the output polarity of an electronic regulator, main motor reversals are obtained by using a bias field and a control field on the armature control generator. The bias field is energized from a separate exciter source. This excitation is such that when the control field excitation is zero (output of electronic regulator) the main generator field will be supplied with full forcing voltage in one direction. When the output of the regulator is one-half maximum, the control field just bucks out the bias field and there is no voltage supplied to the main generator field. Finally, when the regulator is operating at maximum voltage output the control generator supplies full forcing voltage of the opposite polarity to the main generator field. Thus a full range of forcing and regulated voltage conditions are available for both directions of motor rotation. For a typical drive system, motor field rated voltage is 30 v with a full forcing voltage of 230 v (about 8 to 1). Maximum regulator output is 230 v so that bias field excitation is one-half this or 115 volts.

The field control generator also has two fields to obtain a full range of field strengths; however, there is no polarity reversal. The exciter energized bias field supplies full strength to the motor (minimum field regulated speed condition). The control field bucks the bias field, so that any output from the field electronic regulator will decrease motor field strength and incease motor speed. In a typical application, a regulator output variation from 0 to 230 v will give a full range from full to weak motor field (minimum to maximum field regulated speeds).

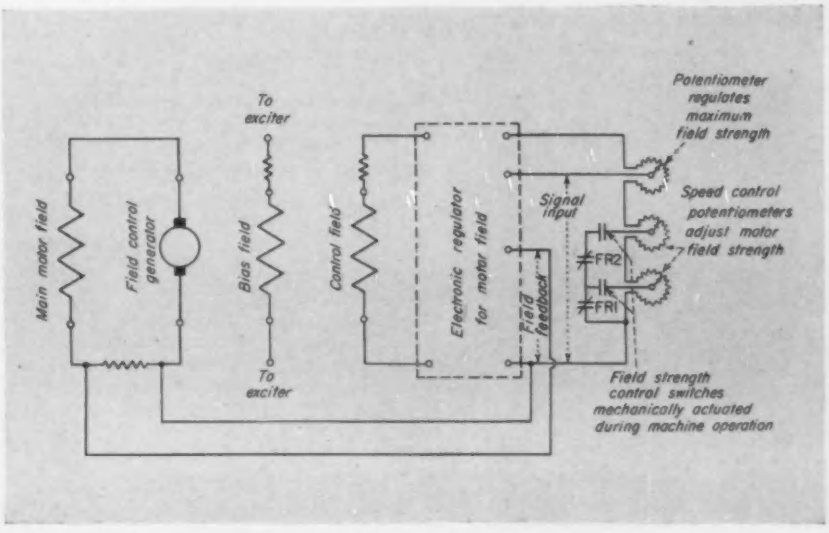
The reference inputs for the various operating speeds obtained by main motor armature control are tapped from several speed control potentiometers that are supplied from a voltage regulated d-c power supply. There is one potentiometer for each operating speed in each direction. As can be seen from Fig. 3, one reference potentiometer is in the circuit at a time, with the proper one being selected by mechanically actuated switches on the driven machine.

The output of the reference potentiometers is opposed by a feedback signal and the difference between these two potentials is supplied as the input to the electronic regulator. This feedback signal is tapped from a voltage dividing network across the armature connections of the main generator and motor (main feedback connection). The difference or error signal drives the regulator, control generator and main generator until the feedback voltage equals the potentiometer reference potential at which time the regulator reduces its output to a point just sufficient to maintain this operating condition.

Since the speed of a shunt wound motor droops slightly with increasing load under a constant armature voltage condition, an armature circuit *IR* drop signal is introduced into the error circuit as positive feedback. Armature current varies with load. Thus a properly selected potential that is proportional to armature current and supplied as a positive feedback signal will appear to the regulator as though the reference potentiometer output was increased slightly to compensate for the speed drop caused by increasing loads. Load independent speeds can be obtained in this manner.

As stated previously a complete range of motor speeds from maximum in one direction, through stop, to maximum in the other direction is obtained by varying regulator output from zero to maximum. It then follows that a complete range of speeds is obtained by varying the reference input potential from minimum to maximum. If the regulated voltage input to the speed control potentiometers is V, then any potentiometers that supply a reference voltage of less than $V/2$ will call for various speeds in one direction, while those that supply greater than $V/2$ will regulate for speeds in the opposite direction. For a stopped condition, the stop contact balances the reference input at one-half regulated voltage.

While stopped (this condition to be discussed in more detail later), relay *SR* is de-energized disconnecting the main generator field from the control generator (open *SR*2) and closing *SR*3 to connect in the auxiliary feedback. This auxiliary feedback connection from the output of the armature control generator keeps the electronic



regulator within range when the output of the main generator is zero.

When the drive is turned on (*SR* energized) any initial signal to the regulator causes the forcing voltage of the proper polarity to be applied to the main generator field. The regulator is a high-gain d-c amplifier with thyration output tubes to drive the field. Its sensitivity is such that output will vary from full-off to full-on with a signal variation of 0.025 v. Amplifier gain is about 10,000 to 1. The forcing condition causes a rapid buildup in main generator field current and thus in field voltage. When the main feedback voltage balances the reference input plus *IR* drop compensation, regulator output reduces to maintain this condition. A main generator to fit into the typical system discussed previously might have a 345 v maximum output under a rated field condition of 30 volts.

Although the forced condition will cause the generator output voltage to rise very rapidly, motor speed may not match this rise because of the inertia and load on the driven member. This lagging condition will result in a motor counteremf that is much lower than the generator voltage and armature current through the motor and generator will be excessive. To restrict the armature current to the highest safe value a current limiting system is used. The current limiting signal is tapped from a resistor network in series with the *IR* drop resistor. This signal is delivered to the control grid of a biased-off triode in the electronic regulator. When armature current reaches a selected limit during a speed changing condition, the triode will pass current and connect the speed input signal across a resistor. This has the effect of causing the regulator to control for a lower final speed and armature current is limited. When this current drops below the safe value, the regulator reverts to the normal desired reference signal. In most forced-torque drives, speed changes are made under this maximum current condition. Thus motor current is the limiting factor during acceleration.

The main motor field control circuit operates in a similar manner to the armature control circuit. The output of the regulator to the control field is determined by the reference signal inputs of several speed control potentiometers. A feedback signal from the main field circuit bucks the reference input signal to close the loop. This circuit shows one potentiometer to regulate maximum field strength and two potentiometers to regulate for weaker field (higher speed) conditions. The control switches to determine field setting are mechanically actuated by the driven member. As described previously, field forcing is also applied to the main motor field to obtain rapid response.

The normally closed relay contacts *FR*1 and *FR*2 are used to insure full motor field strength during drive reversals. Full-field relay, *FR*, is in a parallel and series network of rectifiers and limit switches across the main armature circuit. When the driven member reaches one end of its stroke, the proper speed and direction control switches are actuated in addition to one of the limit switches. (For example, *LS*1). The rectifier in this circuit is correctly placed so that it will pass current and energize relay *FR* to open contacts *FR*1 and *FR*2. This insures full motor field. The relay remains energized while the motor is being decelerated by regenerative braking. Once the motor stops and starts revolving in the opposite direction, armature polarity switches, the rectifier in series with *LS*1 will no longer pass current and relay *FR* drops out restoring field control. The opposite action takes place with the *LS*2 circuit on the other end of the stroke.

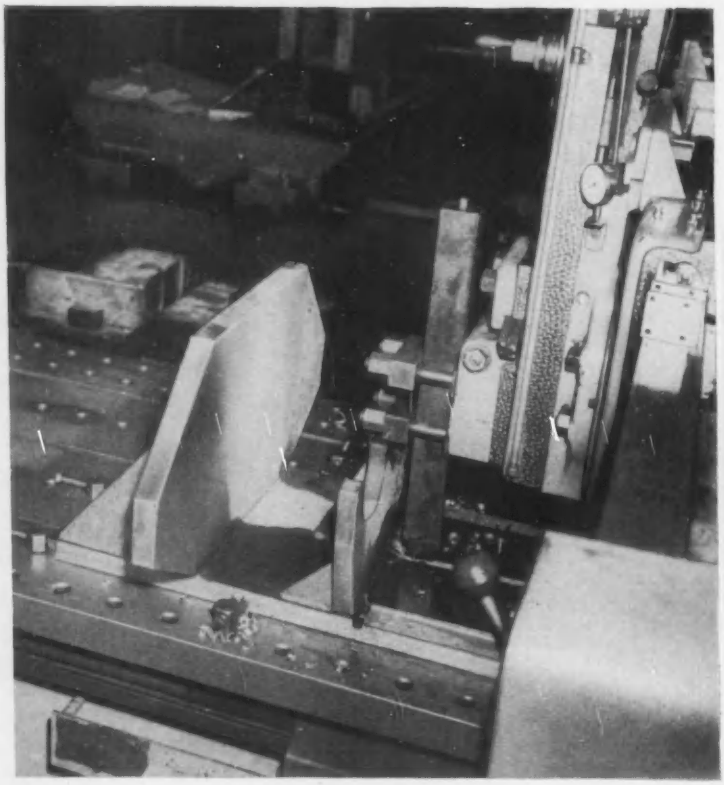


Fig. 4 (Left)—Planer operating against a stop. If drive fails to function properly, provision must be made in the control circuits for emergency stopping to prevent damage to machine and work piece.

Fig 5 (Right)—Schematic diagram of motor field control circuit used on forced-torque drives in the 20 to 150 hp range. Remainder of the circuit (covering motor armature control) that is not shown is the same as the drive represented in Fig. 3.

Stopping, Reversing and Emergency Controls

A forced-torque drive can be stopped by setting the reference input to zero (closing stop contact to obtain balanced condition). This will cause the electronic regulator and control generator to apply a forcing field of the opposite polarity to the main generator. The main motor regenerates back through the main generator and its a-c drive motor to the a-c line. When the main motor stops, the control field of the armature control generator exactly bucks out the bias field and the input to the main generator field is zero. The same braking principle is used during reversals. Current limiting is also used during stopping and reversals since excessive armature current is usually developed during regenerative braking. Actually the speed of braking as well as the speed of acceleration is usually limited by the armature current so that maximum braking is determined by the current carrying capacity of the circuit.

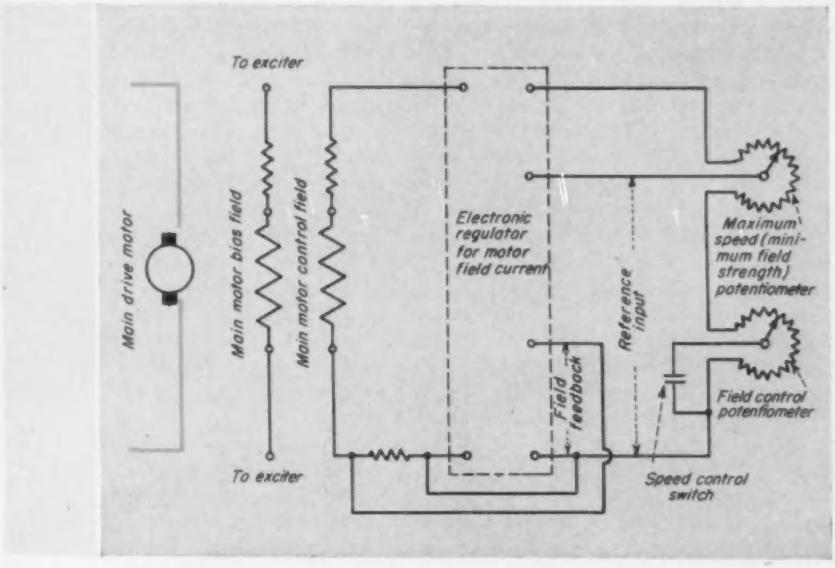
When an armature connected motor generator set is stopped, residual voltage in the generator can cause circulating currents and overheating or even actual creep of the output member. To prevent this, the main generator of a forced-torque drive is suicided; or in other words, the generator field is connected across the armature in such a manner that they buck one another. This rapidly forces the residual voltage to zero. Under normal stopping conditions the non-creep relay is de-energized at about 20 v. Through interlocks this de-energizes the suicide relay (not shown) to disconnect the main generator from the control generator, *SR*2, to connect the main generator field to the armature, *SR*1 and to close the auxiliary feedback circuit. This causes the main generator to suicide and prevents motor creep. Since the generator field is a low-voltage field, it is effective in reducing the armature voltage to less than a volt. When the drive is started again, relay *SR* is energized.

Emergency controls must be included to stop the drive in the event of a-c power failure or regulator failure. This is important in such applications as shown in Fig. 4 where a planer is running up against a stop.

When a-c power fails, relay *PF* (not shown) opens. The main generator field is disconnected from the generator, *PF*1, and connected across a field discharge resistor. When the generator output voltage drops to a safe level (varies from 345 to 200 v in typical system), the emergency stop relay opens and through interlocks the suicide relay is de-energized. This causes the generator to suicide as mentioned above. Since the motor cannot regenerate to the a-c line, the kinetic energy in the motor is dissipated by accelerating the main generator and its drive motor. There is no current limiting since the regulator is disconnected. The ratio of inertias of the mg set to the main motor and its load is usually about 3 to 1. The drive can actually be decelerated more rapidly by this method than by the normal stopping procedure.

Two relays are used to stop the drive in the event of regulator failure. These are the field overvoltage relay in the main generator field circuit and the main overvoltage relay in the armature circuit. The main relay is set to operate at some value higher than the rated voltage output of the generator. If this voltage is reached, the relay de-energizes the power failure relay, *PF*, and the unit stops as covered above. The field overvoltage relay is set at some value between rated field voltage and the maximum field-forcing voltage. Under normal operating conditions the generator follows rapidly enough so that this voltage is not reached. However, if this voltage is exceeded during a fault condition the drive will suicide and stop.

This covers the most complicated type of forced-torque drive. Other horsepower ranges use simpler versions of this basic circuit.



Range from 20 to 150 horsepower

With the exception of variations in the field control networks, the same control circuitry is used in this range as in the higher horsepower installations. As shown in Fig. 5, no field control generator is required since the main motor control field power requirements are low enough to be supplied directly by an electronic regulator. Note that the main motor has two fields in this system.

The bias field and control field aid instead of buck each other. The exciter energizes the bias field to give a weak field condition which is increased by control field excitation to give maximum field strength. Field forcing and feedback are used. With this arrangement minimum field strength is determined by the reference input potentiometer that is continually in the circuit, while decreased field strength set-

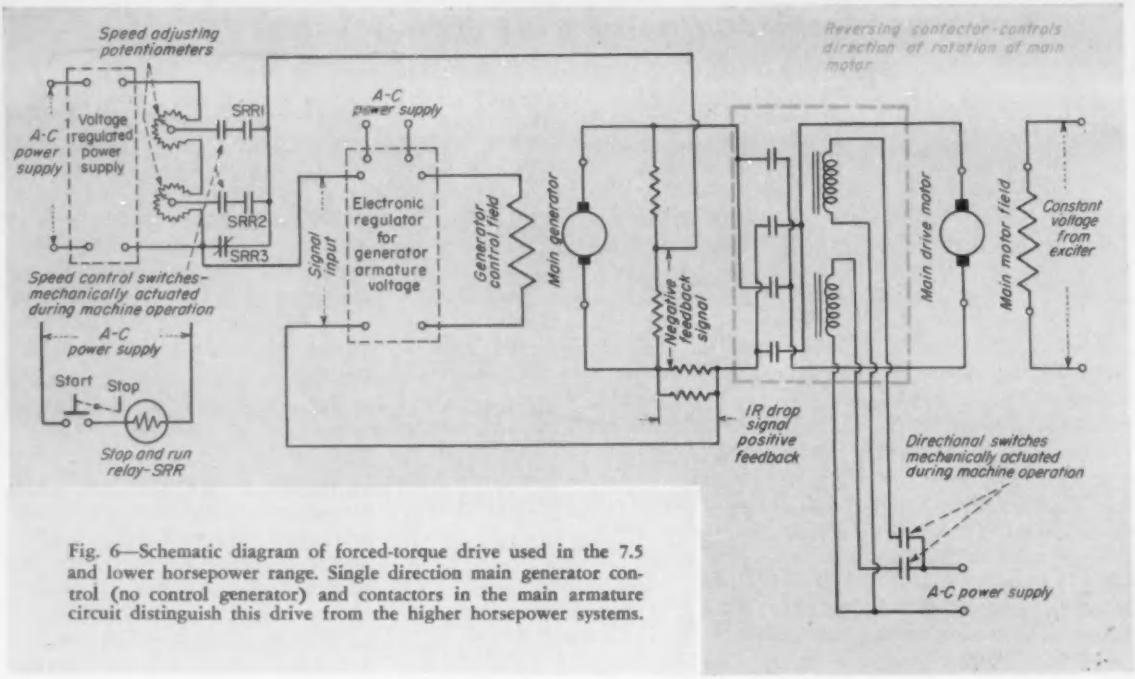


Fig. 6—Schematic diagram of forced-torque drive used in the 7.5 and lower horsepower range. Single direction main generator control (no control generator) and contactors in the main armature circuit distinguish this drive from the higher horsepower systems.

tings are obtained by closing the speed control switch on the other potentiometer. As many different field-regulated speeds as are required can be obtained by increasing the number of speed control potentiometers and the number of speed control switches.

Range from 10 to 40 horsepower

The normal application in this horsepower range does not require variable field excitation and the main motor field is supplied directly from a constant voltage exciter. The remainder of the circuit can be essentially similar to the arrangements used in the higher horsepower ranges. This will be a constant torque variable horsepower system since the motor armature voltage varies but the motor field strength remains constant.

For 7.5 horsepower and less

Forced-torque drives in this horsepower range vary from the ones discussed above. In the larger drives, motor reversal is obtained by reversing the field of a control generator. This is done for two reasons: first because it is impractical to reverse the polarity of the electronic regulator, and second because reversing contactors that would be suitable for use in the main armature circuit are relatively expensive and have a very limited life span for this type of duty cycle application.

In contrast, the armature current in the low capacity drives, Fig. 6, is small enough to be handled by Size 1 or 2 contactors. This size is relatively inexpensive and has a satisfactory life rating even under a duty cycle that includes frequent reversals. Actually, it has been found that most applications of the low capacity forced-torque drives are unidirectional so that the contactor is only operated in a stop condition to prevent creep caused by residual voltage.

The system consists of the standard type of reference input and electronic regulator; however, there is no control generator and the regulator directly supplies the single field of the main generator. The regulator only supplies from minimum to maximum field excitation in one direction since the reversing contactor takes care of drive reversals. A negative feedback signal is taken from a voltage divider network on the output of the main generator and IR drop compensation is used to prevent speed droop with increasing load. The direction of operation is determined by directional switches that energize one or the other coil of the reversing contactor. No motor field control is used and field excitation is taken from a constant voltage source. Operating speed is determined by speed control switches that select the proper reference potentiometer. High speed regenerative braking can be obtained by setting the reference input at zero (de-energize relay *SRR* and close *SRR*3) and reversing the motor contactor. The motor will then regenerate through the main generator and stop.

Because of the relatively low time constant of the generator field (L/R equals about 0.1 sec), only a small amount of field forcing is used. In a typical application, rated field voltage is 180 v and full-forcing voltage only 260 v. Greater amounts of field forcing are not required since the response of the system is satisfactory with less than a 2 to 1 ratio of rated to forcing voltage. No current limiting control is used since the output of the regulator can be limited to a maximum value which will not cause excessive currents. Suiciding circuits are not required since the line contactors can be opened to prevent creep. Suitable emergency controls similar to those used on the higher horsepower drives can be incorporated in these low capacity systems.

Besides the special control circuitry, most of the forced-torque drives in the various horsepower ranges require special drive motors because of inertia and shock load specifications.

Drive Motor Selection Factors

The three primary considerations in selecting a motor for a forced-torque drive are: (1) Low inertia; (2) High peak commutating ability; (3) Mechanical strength to resist shock caused by high accelerations.

Since angular acceleration varies directly with inertia for a given torque, motor rotor inertia and the reflected inertia of the driven members at the motor shaft materially affect the time required to accomplish a given change in motor speed. In these applications, motor inertia is particularly important since it is usually much greater than the reflected inertia because of gear reduction stages between the motor and final load. For example, in a 50 hp planer drive, a table weighing 21,000 lbs and carrying more than its own weight has a reflected inertia of 33 lb/ft² at the motor shaft, while motor rotor inertia is 81.6 lb/ft². This being the usual condition, anything that can be done to reduce motor inertia is reflected in improved response of the drive and driven machine.

Thus a motor used on this type of drive should have as large a length to diameter ratio as is possible. Typical special motors have inertias that vary from $\frac{1}{3}$ to $\frac{1}{2}$ the inertia of standard motors of the same rating. These motors present problems in holding the long coils in their slots and in picking up the current from the commutator.

Pole shape, frame thickness and commutator design are important factors in determining the commutating ability of a motor. Units have been developed that will deliver maximum power of four times rated full load without sparking at the commutator. This means the current limiting control can be set at four times full load current. For example, a 50 hp, 250 rpm, 60 min motor approximates the thermal requirements of the type of duty cycle encountered in typical planers.

To withstand the mechanical shock caused by the suddenly applied torques, these motors are usually designed with oversize rotor shafts and bearings and specially constructed commutators and rotor coil retainers. This does not always apply in the small capacity drives, since the rotors of small standard motors have a sufficient factor of safety to withstand the developed torques and accelerations.

Drive motors are usually supplied by the manufacturer along with the drive since every new application presents different problems and may require the design of a new motor.

Other Design Considerations

In designing a machine to be powered by a forced-torque drive the most important thing is to integrate the drive with the initial design. In this way maximum benefit is obtained. Reflected inertia to the motor shaft should be kept low by designing the reduction gearing for minimum inertia. Special attention should be paid to high speed rotating members; for example, an inertia reduction of from 10 to 30 percent has been obtained by replacing a standard motor shaft-to-pinion coupling with a light-weight compact type of coupling.

Cost comparisons to determine whether it is feasible to use a forced-torque drive instead of a conventional system should include the cost of the gear changing devices, mechanical brake, mechanical clutch and other auxiliary equipment that are required with the conventional drive, in addition to the cost of the conventional drive motor that is being replaced.

One factor in designing a drive is to determine how large an mg set to use. For example, if the speed of a drive is to vary from 250 rpm to 1,200 rpm the range from 250 to 750 might be obtained by increasing the voltage output of the main generator and the range from 750 to 1,200 by weakening the field of the main motor. This entire speed range could be obtained by field weakening; however, since this is a constant horsepower process, the torque at high speeds would be reduced causing low accelerations and poor response to reference signal variations. Thus the mg set is specified at three times its required rating (250 to 750 rpm) to obtain high torque and acceleration.

The percentage of the speed range covered by armature voltage variation and motor field weakening is arbitrary

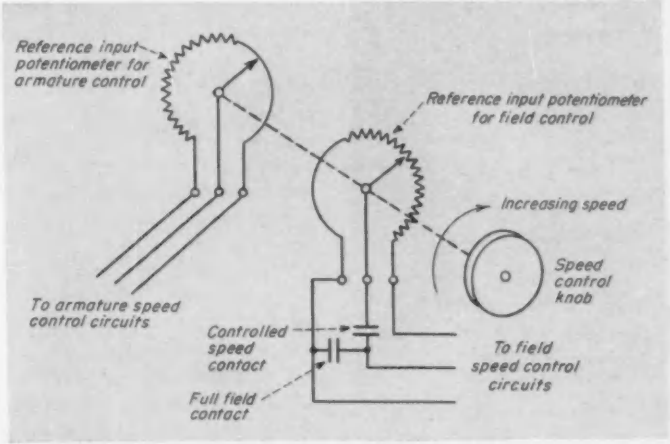

Reference input potentiometer for armature control
Reference input potentiometer for field control
Increasing speed
Speed control knob
To armature speed control circuits
Controlled speed contact
To field speed control circuits
Full field contact

Fig. 7—Ganged field and armature speed control potentiometers. With this arrangement maximum armature regulated speed is reached before field weakening is begun.

and varies from application to application. Usually constant horsepower operations (such as cutting metal) use some field control, while transferring operations and frictional loads use armature control. Where a machine uses both armature and field control, the speed control potentiometers are often ganged as shown in Fig. 7, so that one knob adjusts both units. The armature control potentiometer varies for a certain percentage of the speed range and then becomes constant, while the field control potentiometer is initially constant and then varies to increase the drive speed after the highest armature setting is reached.

In applications where the stopping position must be accurately maintained the drive is often slowed to a creep speed a short distance before it is finally stopped. This means that stopping is not only done from a low speed, but also from a constant speed that is affected very little by variations in loading. An example of this is an automatic conveyor in an auto engine manufacturing plant. The 100 ft conveyor transports a total weight of 3,500 lbs a distance of 100 in. in 1.5 sec and stops consistently within $\frac{1}{8}$ in. This is accomplished by slowing to a creep speed before the final stop.

Actual Application Circuits

The following material covers forced torque drives for a 5 hp hosiery knitting machine and a 50 hp planer. While essentially similar to the basic circuits discussed previously, these show some of the problems encountered in actual drives.

The hosiery knitting machine drive, Fig. 9, is based on the fundamental low range drive circuit shown in Fig. 6 and replaces a complicated mechanical speed changing system formerly used on this type of machine. The principal advantage of a forced-torque drive in this application is a reduction in required maintenance. The mechanical system performed satisfactorily while operating. However, frequent failures resulted in a high percentage of down time.

This drive is unidirectional so that the main motor contactor, *M*, only makes and breaks the circuit. The constant voltage source for the main motor field and the reference input potentiometers is obtained from a transformer, *T*1, feeding two diodes connected for full-wave rectification. The six reference potentiometers give a creep speed for machine set up and the five operating speeds, I to V, that are required to knit a complete stocking. The main generator field (control field) is supplied by a transformer, *T*2, feeding two triodes connected for grid controlled full-wave rectification. The grid control network is energized by the signal input from the reference input, negative feedback connection and positive *IR* drop feedback connection to control the rectified voltage (from full-forcing to zero) applied to the generator field.

The main motor contactor, *M*, is energized from an additional secondary of transformer *T*2. The power failure and undervoltage relay, *PR*, de-energizes contactor *M*, *PR*1, and the reference voltage source, *PR*2, in the event of power failure. De-energizing contactor *M* opens the main armature circuit, *M*1, and the generator field circuit, *M*4, and shorts the motor armature across a resistor, *M*2. A Size 2 contactor is used as the main motor relay.

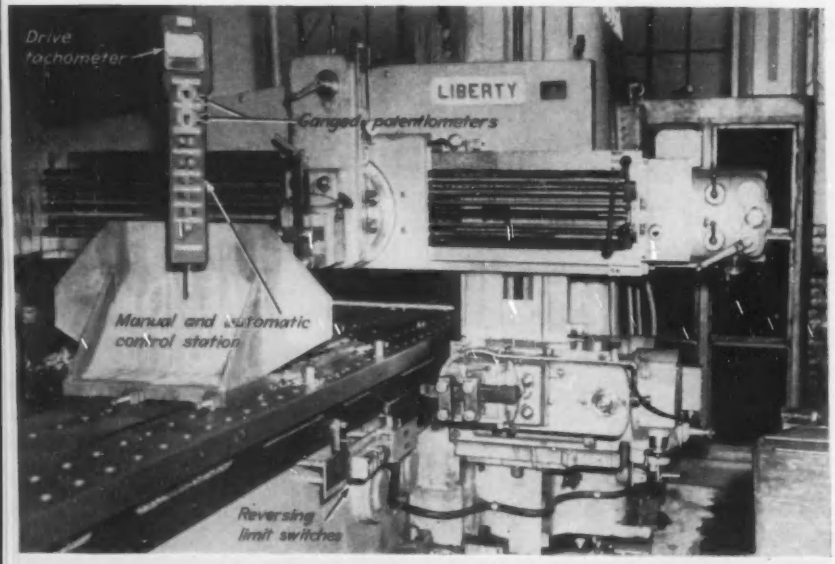


Fig. 8—Planer driven by 50 hp forced-torque system. Bed speeds vary from a maximum of 300 fpm (1,200 rpm motor speed) to a minimum of about 10 fpm (250 rpm motor speed).

The basic circuit of Fig. 3 can be modified to suit the specific needs of a 50 hp planer drive. Since this drive falls in the 20-150 hp range no control generator is used in the field control circuit and the main motor control field is supplied directly from the output of an electronic regulator. Only the significant features of the drive will be pointed out.

Limit switch and manual pushbutton control circuits include provisions for controlling the direction of motion during automatic operation, inching controls for both directions used during machine set up, and a reduce speed relay which enables the operator to reduce the drive speed if the tool hits a hard spot in the workpiece. The drive can be started at any time by actuating either the automatic cut or automatic return pushbutton. These are interlocked so that only one can be operated at a time.

Under automatic operation a limit switch is actuated to open at the end of the return stroke. This breaks the

circuit to the return relay and energizes the cutting relay reversing the drive. Another limit switch is actuated at the cutting end of the stroke and the opposite action takes place.

The reference input circuits to control the main generator output have reference input potentiometers to control drive speed in the cut direction, and return direction. These potentiometers are mechanically ganged with the field weakening potentiometers, with the proper potentiometer being selected by the stroke relay contacts. When the reduce speed relay is manually actuated by pressing the slow-cut pushbutton, the main generator reference input is transferred to the slow-cut potentiometer. This does not affect automatic operation, and upon release of the slow cut pushbutton the drive reverts to its normal cutting speed.

The main motor field control circuits have cutting and return speed control potentiometers that are also controlled by the stroke relays. As mentioned previously these potentiometers are mechanically ganged with the main generator control potentiometers so that maximum armature regulated speed is reached before field weakening takes over. On actuation of a full field relay, (across main armature circuit) or the slow cut pushbutton, motor field strength is switched to maximum during reversals or slow cut conditions.

The control generator, main generator and main motor circuits contain conventional components as discussed in connection with Fig. 3. One additional element is a lead network which is used to prevent overshoot under rapid speed changing conditions. When using field forcing, the rapid increase of field current under a forced condition would cause a current overshoot if regulator action is not initiated until the desired field current value is reached. The lead network prevents this overshoot by increasing the main generator feedback signal (or decreasing it depending on direction of speed change) so that the regulated output appears to be closer to the desired value than it actually is. Thus the regulator output starts reducing before the desired main generator output voltage is actually reached. This network is only effective during transient conditions and does not influence circuit operation under steady conditions.

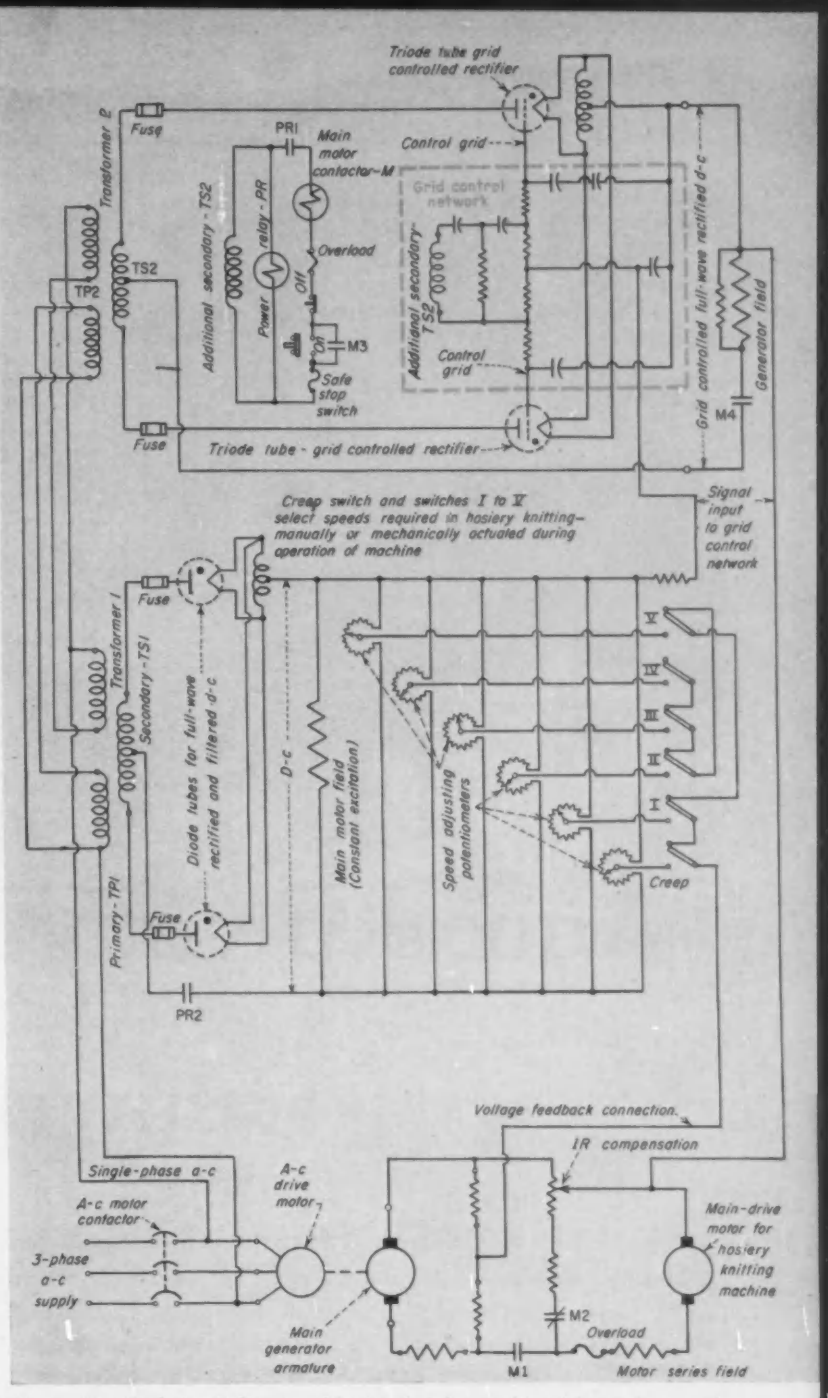


Fig. 9—Simplified circuit diagram of hosiery knitting machine drive such as used on machines shown in Fig. 1. Speed selecting switches I to V are actuated by the chain projections. Low-power unidirectional drive is stopped and started by main contactor.

An independent exciter supplies constant excitation bias fields for the armature control generator and main motor. In addition, the suicide relay control network is across the exciter so that the relay will not drop out immediately on failure of the main a-c power supply.

When the power to the a-c emergency control circuit fails, the main generator field is disconnected from the control generator, and connected across a field discharge resistor. In addition the manual and automatic control station is de-energized. When the main armature voltage is reduced to some safe level, a suicide voltage relay is de-energized. This suicides the main generator. The other emergency controls operate as discussed previously.

Table I—Annealing Treatments for Gray Iron

Treatment	Purpose	Type	Temp., F	Time, Min. per in. of cross-section thickness	Cooling Procedure	
					Type	Rate
Low Temperature	Breakdown of pearlite to ferrite and graphite for maximum machinability	Plain and low alloy irons	1300–1400	45–60	Furnace	100 F per in. between 1,000–550F
Medium Temperature	Above	High alloy irons	1450–1650	Approx. 45	Furnace	From annealing to 550 F
High Temperature	Elimination of massive carbides in mottled or chilled areas.	High alloy irons	1650–1750	60–80, plus 60 min. per in. of section thickness*	Air cool furnace	1000–550 F
	Retention of maximum strength and hardness, maximum machinibility		1650–1750	Above	Furnace	From annealing to 550F

* Carbides may often be eliminated in shorter times.

Annealed Gray Iron Castings .... *For Cost*

CHARLES O. BURGESS
Technical Director
Gray Iron Founders' Society, Inc.

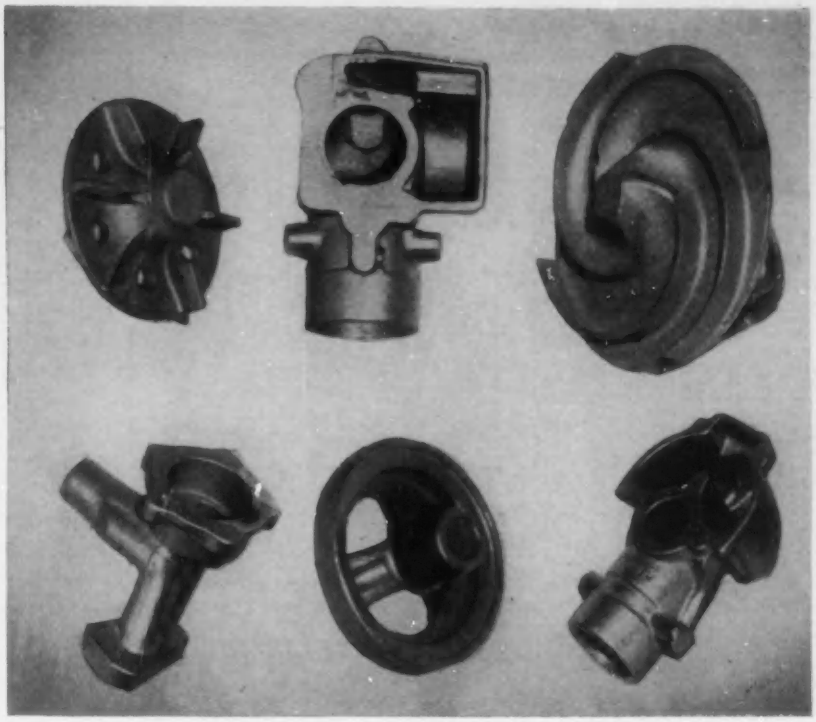
THE USE OF ANNEALING to improve the machinability of gray iron is gradually spreading. This heat treatment has been applied most commonly to castings, particularly those to be subjected to high speed machining operations, such as in the automotive industry. Now its scope of application is broadening considerably, encompassing, among others, air conditioning machinery parts, pipe fittings, and textile equipment parts. The degree of increased machinability obtained introduces savings in time, tool replacement, and power that far outweigh the cost of the annealing process. Besides saving costs, the process also affects the physical properties of gray iron since it produces basic structural changes.

Particular combinations of properties can be achieved by precise annealing schedules. The softer annealed irons possess, in addition to their greatly increased machinability, an increased resistance to impact. Also introduced are certain increases in damping capacity, thermal conductivity, and related electrical properties. (Ref. 1) An incidental, though frequently very desirable, result of annealing is the relief of internal stresses in the casting. It has also been found advantageous to anneal gray iron before enameling. However, on the distaff side, the resultant improved machinability is usually accompanied by some decrease in strength and hardness, but modifications of annealing schedules can be devised to offer a suitable balance.

The relatively pronounced effect of annealing gray iron—improvement of machinability—results from the unique ability of gray iron to form soft graphite and ferrite from hard iron carbides. Unless annealed, gray iron also contains a certain amount of combined carbon or cementite which, in turn, is found in two forms:

1). As massive, hard crystals—In mottled iron, these exist as isolated crystals imbedded in the matrix, and constitute in chilled or white iron a major part of the structure. Since these crystals are extremely hard, mottled and white irons are difficult to machine.

2). As a constituent in pearlite—



CHARLES O. BURGESS

It was with deep regret that we learned that Mr. Burgess died on Jan. 13. Previous to becoming technical director of the Gray Iron Founders' Society in 1948, he was head of industrial service in the research division of Union Carbide and Carbon Corporation.

Savings and Better Properties

Annealing gray iron improves not only its machinability, but also its physical and electrical properties. Particular combinations of properties can be obtained by precise annealing schedules. This article is based on a chapter of the book "Heat Treatment of Gray Iron" soon to be published by Gray Iron Founders' Society, Inc. The reference numbers in the text refer to the bibliography at the end of the article.

Here it consists of alternate layers of cementite and ferrite. Found in most gray irons, this combined form does not seriously hinder machining operations as it is usually finely divided. In fact, its presence is often desirable where high strength and wear resistance are important.

However, the most easily machined gray irons are those consisting entirely of ferrite and graphite; even five percent of free cementite has a noticeable detrimental effect on machinability. (Ref. 2) The purpose of the annealing process, therefore, is to break down or separate the pearlite or free cementite, by the application of heat, into its component elements of ferrite and graphite. Such decomposition of pearlite is not possible in steel. The pearlite in steel may be transformed by annealing into the somewhat more machinable spheroidal form. But the most desirable combination, ferrite and graphite, can only be obtained in gray iron, where the existing graphite flakes serve as centers for the decomposition of free carbon during annealing.

Annealing itself is directly dependent on temperature. Basically, gray iron annealing, Table I, is concerned with three different temperature ranges: low, 1300-1450 F, medium, 1450-1650 F, and high, 1650-1750 F, with particular temperature application

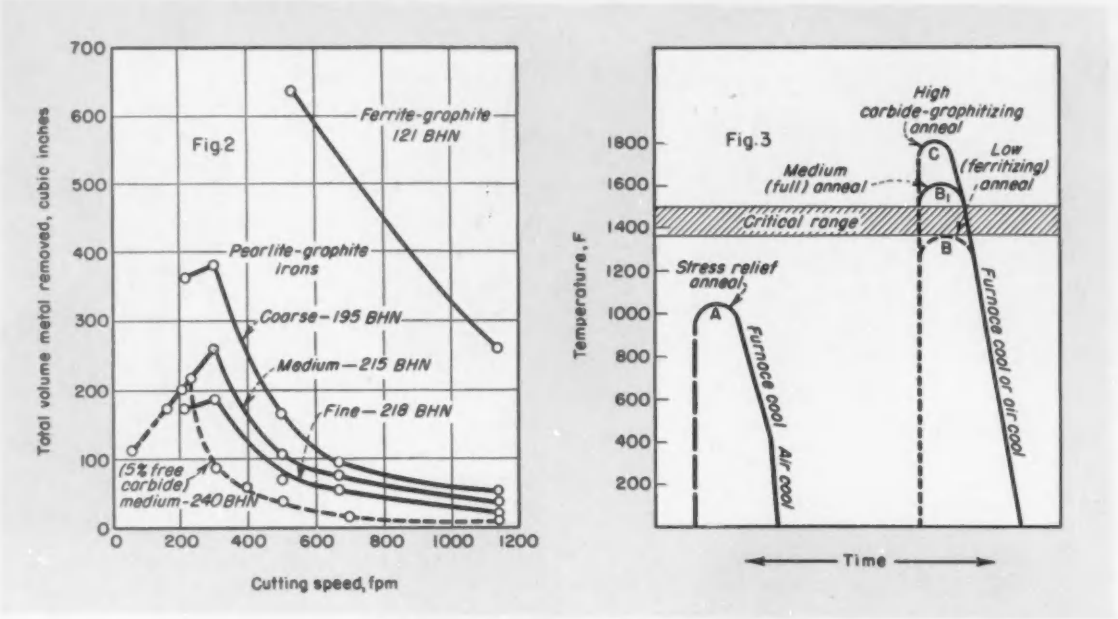


Fig. 2—Metal removal at various cutting speeds of annealed and unannealed gray iron before tool wear. Machinability increases as much as fifty times after annealing. Annealing also reduces power requirements.

Fig. 3—Heating and cooling curves for various types of anneal. Low anneal induces maximum machinability.

being dependent on the critical temperature of the gray iron being annealed. Normally, for example, the critical point in a pure iron-carbon alloy is 1346 F. But in the gray iron containing 2.0 percent silicon and 0.70 percent manganese, the annealing temperature increases to 1415 F, (Ref. 3,4) resulting from the equation:

Critical temperature = 1346 F + 50 deg (percent Si) —45 deg (percent Mn).

Where a low temperature anneal may be insufficient because of the high alloy composition of the iron being cast, a medium or "full" anneal is employed. The use to which the iron is to be put dictates the cooling rate. If it is desired to retain maximum strength and wear resistance, the principle object of the treatment will be to break down carbides. The casting will then be air-cooled from the annealing temperature to about 1000 F to promote the formation of a pearlite structure. If maximum machinability is the object, the casting is furnace cooled to 1000 F with special care to slow cool through the critical range. (Ref. 5) To avoid internal stresses, cooling from 1000 F to approximately 550 F does not usually exceed a rate of 100 F per hour.

Improvement in Machinability

In gray iron, annealing greatly improves machinability from two standpoints: increased tool life, and reduced power requirements, which in turn permits the utilization of less powerful and therefore less costly machine tools for machining operations.

Estimates determined from the total volume of metal removed at given cutting speeds before the wear on a carbide milling cutter exceeded a "wear land" of 0.030 in., Fig. 2, indicate that the machinability of completely annealed iron is fifty times as great as that of unannealed gray iron at a cutting speed of 300 feet per minute, and eight times as great at a cutting speed of 1,100 feet per minute. (Ref. 2) In addition, the power requirement can be reduced $\frac{1}{2}$ to $\frac{2}{3}$ of that required for unannealed castings. In one instance where 2,000 castings were machined per day, the use of a low ferritizing anneal, corresponding to that represented by curve B in Fig. 3, introduced a saving of 1,500 dollars a week on cutter grinding. To this must be added value of greater production.

Secondary Annealing Effects

A suitable balance between machinability and other properties can be effected frequently by modification of annealing schedules. Double treatment, for example, produces a machined casting which is resistant to the most severe abrasive conditions. (Ref. 6) This application, a 27-29 percent high chromium cast iron pump impeller casting, possesses a Brinell hardness of approximately 300 when annealed at 1475 F. However, after machining, heating again to 1800 F, and forced-air quenching, its Brinell hardness is increased to 650-700. Similar double heat treatments achieve equal success with plain and low-alloy gray irons.

Improving machinability without reducing strength to the comparatively low level found in a pure ferrite-gray iron is often obtained by a partial anneal, involving the breakdown

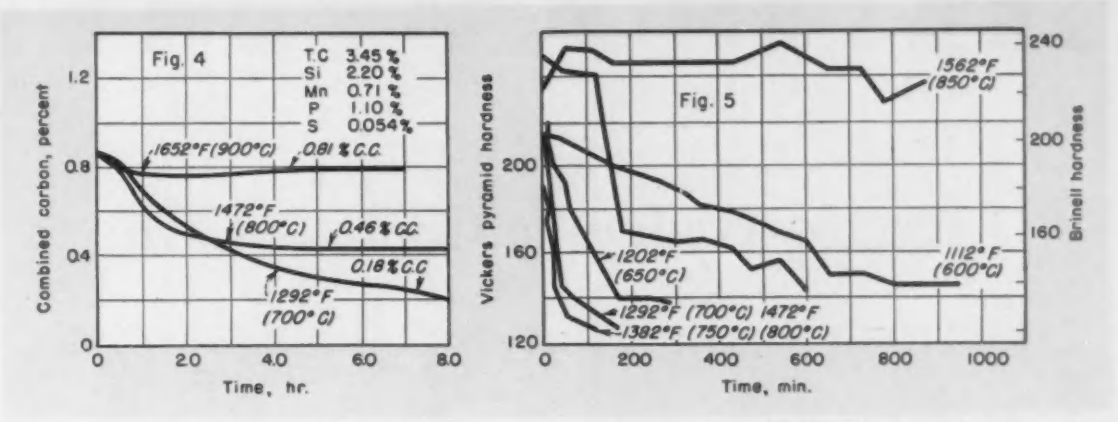


Fig. 4—Effects of three different annealing temperatures on the combined carbon content is shown by these three curves. The detrimental effect of the super-critical temperature on the carbon content is evident.

Fig. 5—Effect of annealing temperature and holding time on a gray iron containing TiC-3.38 percent, Si-1.93 percent, Mn-0.72 percent, P-0.10 percent. Air cooled in furnace from annealing temperatures.

Table II—Effect of Annealing on Gray Iron Hardness

Hardness, Brinell	Tensile Strength, psi As Cast	Tensile Strength After Annealing, psi	Alloy Addition to Base, Percent				
			Cr	Mo	Cu	Ni	V
217	46,200	44,500	0.61	0.56			
207	50,600	43,100	0.47	0.43	0.52		
207	41,700	40,000	0.56				
201	43,000	38,200	0.50		0.52		
197	55,500	42,600	0.49	0.43		1.45	
187	52,400	37,400		0.54	0.65		
179	48,400	40,000		0.47			0.13
156	45,400	34,800	0.49			1.45	
156	50,000	33,000		0.54		0.66	
156	41,000	31,200					0.12
149	41,700	29,900				1.72	
146	44,000	31,600		0.47			
143	43,500	29,900			1.80		
143	27,000	37,400	Plain				

of only part of the pearlite and the spheroidization of the remainder. This partial anneal is frequently employed in gray irons to which alloying elements have been added to get improved strength and wear resistance. As shown in the accompanying Table II, those irons containing chromium exhibit the least change in hardness after annealing.

Surface scaling and casting distortion are frequently considered to be problems caused by annealing. It is true that some oxidation of the surface, or scaling can take place at high temperature annealing, unless a controlled atmosphere furnace is used. (Ref. 7) Too rapid rates of heating to or cooling from the annealing temperature can also cause distortion in the casting. However both of these effects are usually absent when the lowest possible annealing temperature is employed.

BIBLIOGRAPHY

1. Vanick, J. S. "Engineering Properties of Heat-Treated Cast Irons". Transactions, American Foundrymen's Society, V. 54, 1946, pp. 460-464.

2. "Increased Production, Reduced Costs Through a Better Understanding of the Machining Process and Control of Materials, Tools, Machines." U. S. Air Force Researches Planning Section, Industrial Planning Division, Air Material Command. Curtis-Wright: Wood-Ridge, New Jersey, 1950.

3. Bolton, L. W. "Soft Cast Iron". Bulletin, British Cast Iron Research Association, V. 41, July 1934, pp 6-10.

4. Gnoengress, H. W. "Surface Hardening of Gray Iron in the Machine Tool Industry". (in German) VDI Zeitschrift, Verein Deutscher Ingenieure, V. 71, March 1, 1951.

5. "Heat Treatment of Cast Iron". Report and Recommendations of Sub-Committee T. S. 31. Foundry Trade Journal, V. 91, August 2, 1951, pp 117-124.

6. Private communication, W. W. Brown, Carondelet Foundry Company, St. Louis, Missouri.

7. Bader, M. "Notes on the Heat Treatment of Gray Cast Iron". Engineering Digest, V. 1, February 1944, pp 165-167.

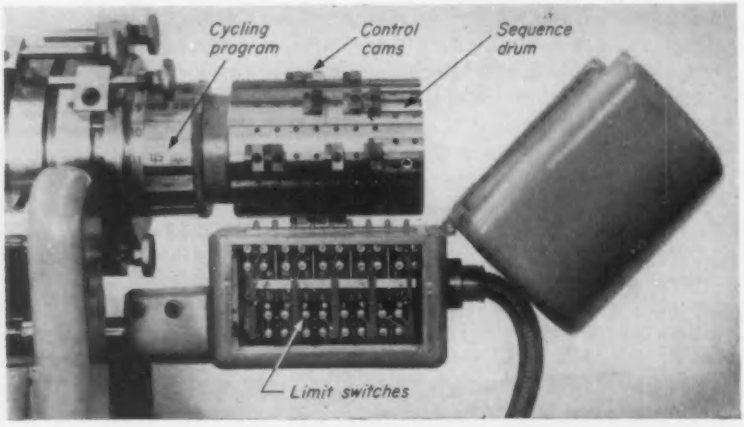
Electro-Hydraulic Controls Give German Lathe Split-Second Response

By electrically actuating a series of hydraulically operated friction clutches which transmit the driving power through a constantly in-mesh gear train, Gildemeister & Co., has come up with a control system for their new turret lathe that enables split-second changing of spindle speeds and feeds. Selection of 16 different speeds, forward or reverse, and 8 feeds can be delivered in any sequence to the 16 turret head tool positions. Using a manual pre-selector device or an automatic programming unit, both of which use the same groups of control components, the selection and engagement of speeds and feeds can be controlled either simultaneously or intermittently.

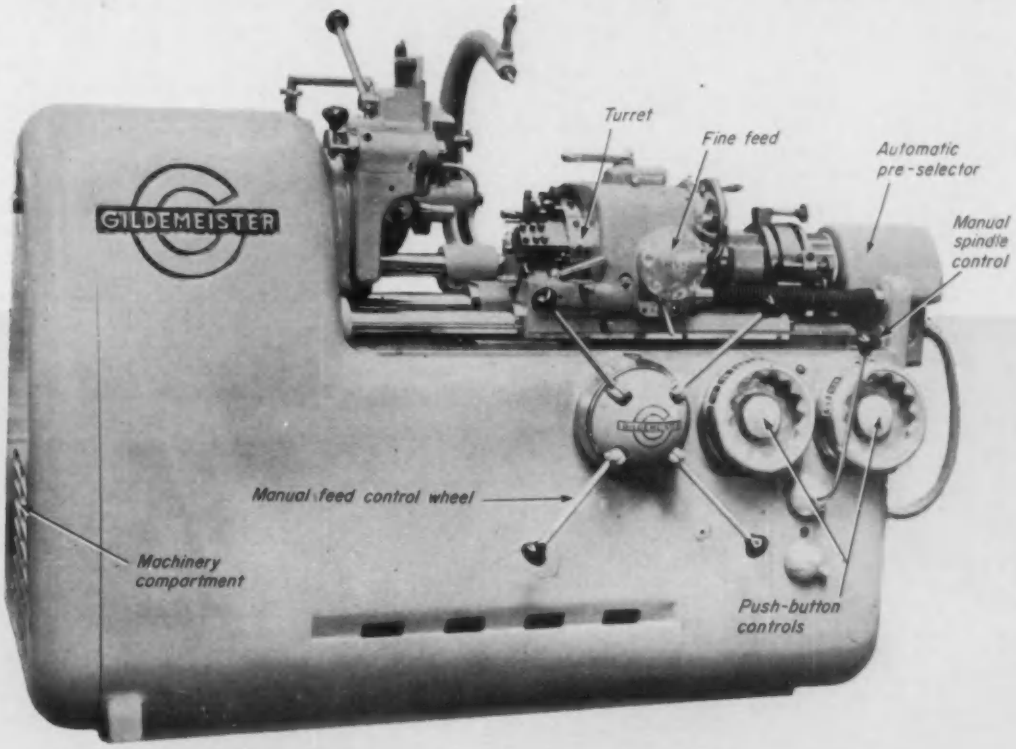
The control system essentially consists of separate groups of hydraulic solenoid valves related to speed and feed selection. When the electrical signal is received from the pre-selector or sequence control drum, the solenoids position their integral valves to direct the flow of hydraulic fluid to the proper clutch control pistons. Shifting of the pistons moves the friction clutches in or out of engagement to set up the necessary power transmission through the speed and feed gear units. Also incorporated in the electro-hydraulic controls is the immediate releasing of the spindle drive clutch and hydraulic braking of the spindle to prevent transmission of any belt or gear thrust when shifting from one speed to another.

An important design feature of the lathe is the construction and location of the drive mechanism. A minimum of gears and moving parts make up the drive, the drive being positioned low in the frame to minimize vibration. Also, being packaged at one end of the machine, the lathe production is not interferred with since it can be tested independently of the lathe. And if damage occurs, a new unit can be quickly installed. The lathe is distributed in the U. S. by Kurt Orban Co., Inc., New York, N. Y.

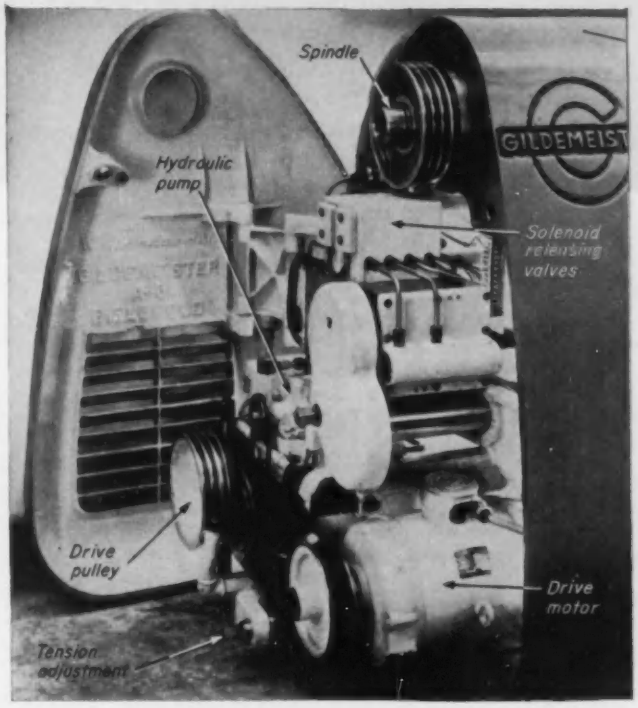
AUTOMATIC SEQUENCE control is built into the lathe by using the protruding end of the turret spindle. Cams positioned on the drum surface pre-select the speed, feed and spindle direction for the next tool position. As the turret indexes, the cams contact the limit switches located under the drum, electrically actuating the proper solenoid valves in the drive control units to position the necessary clutches. Spindle direction is tied in directly with the motor rotation.



IN NEW PRODUCTS



CAPABLE of dropping from a spindle speed of 2,000 rpm to 11 rpm within a fraction of a second, the new RV-50 turret lathe is designed for cutting speeds as high as 1,080 fpm at maximum bar capacity of the spindle.



THE "UNITIZED" DESIGN principal is illustrated by combining the feed and speed units, together with the motor, hydraulic pump and necessary hydraulic components into a complete and removable assembly. Belt tension is easily adjusted by a fine screw adjustment which also acts as the fulcrum for the drive unit.

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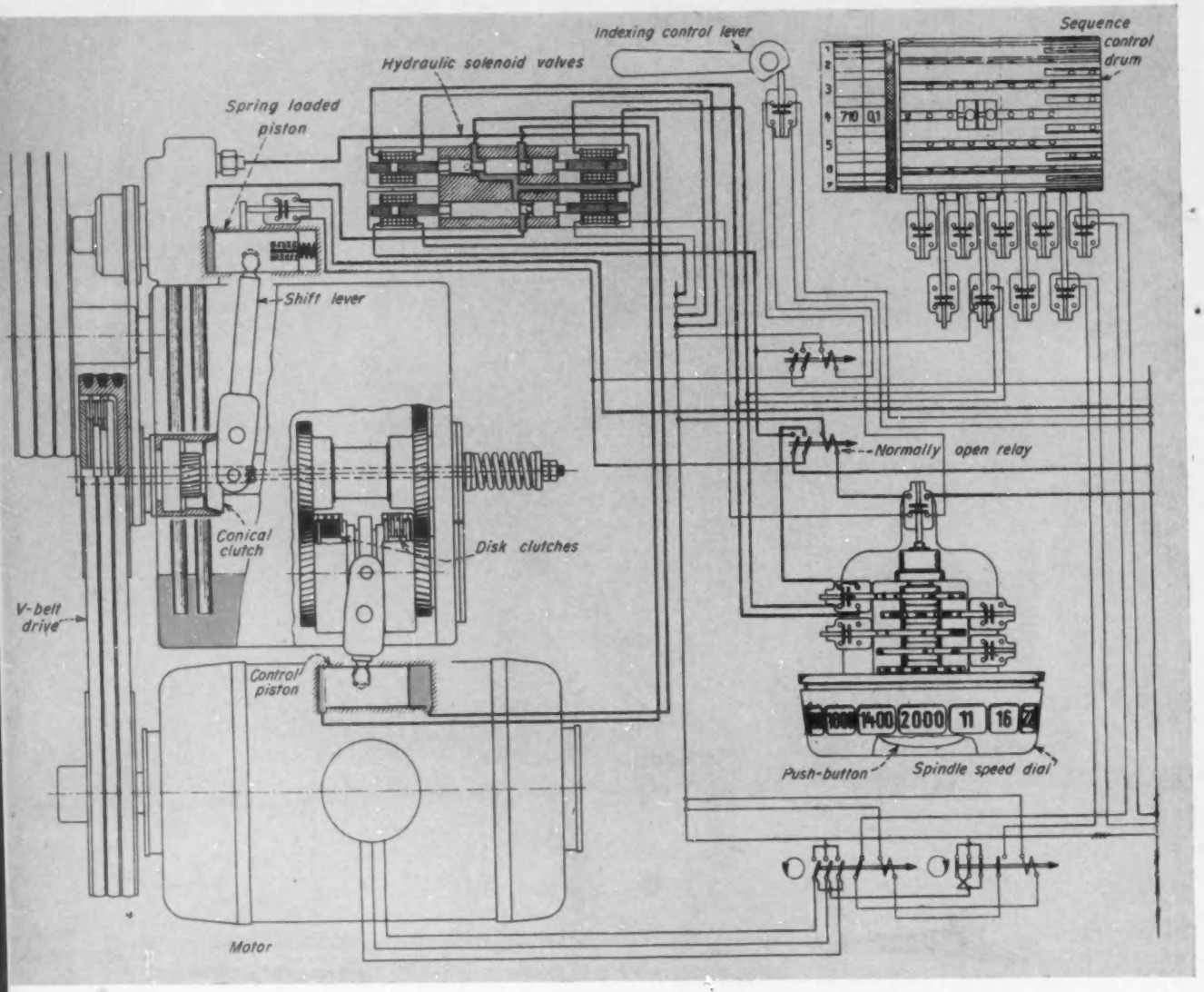
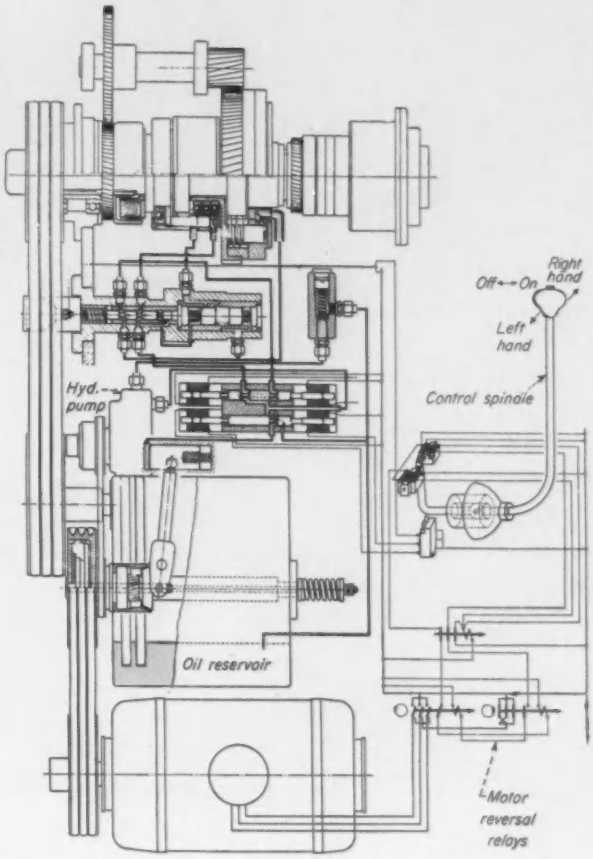


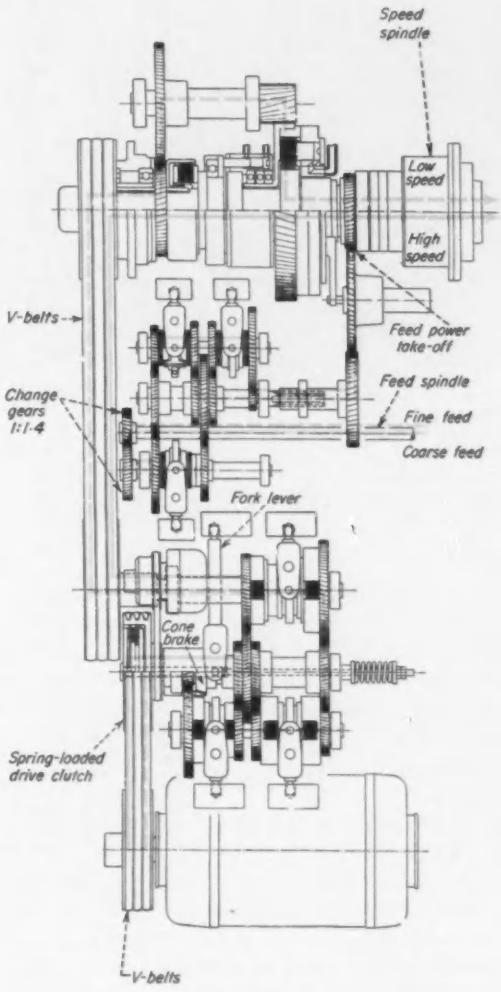
ELECTRO-HYDRAULIC DIAGRAM shows principle of operation using the manual speed pre-selection device or automatic sequence control. For hand pre-selection, the operator selects the speed and pushes the dial button to initiate the control cycle. The dial control cams bridge the circuit cycle to the solenoids related to the speed selected. Shifting of the hydraulic valve allows oil pressure to shift a spring loaded piston which, in turn, actuates a shift fork lever. The lever then relieves the spring loaded drive clutch. In its end position, the lever closes a contactor with a pivot lever allowing the pre-selected circuit to open another solenoid valve. Oil pressure is led to the control piston of the open valve and by a fork lever the drive disk clutch corresponding to the preselected speed is engaged. Upon engagement, the solenoid valve closes and the spring loaded piston connected to the drive disk clutch returns to its original position.

GEARING LAYOUT of the lathe shows the transmission of power for the high and low speed ranges and the coarse and fine feed ranges. Both the speed and feed units are built up on the ratio principle with 15 helical cut gears covering the 16 possible speeds with 13 gears giving 10 feeds. Note the spring loaded drive clutch assembly. This unit is designed to immediately release the spindle from the drive when speed changes are made. Hydraulic pressure pivots the fork lever to relieve the spring compression on the drive clutch, and at the same time a conical brake is pressed into a revolving ring to brake the spindle. These features act to prevent any loads being transmitted to the spindle during the speed change operation.

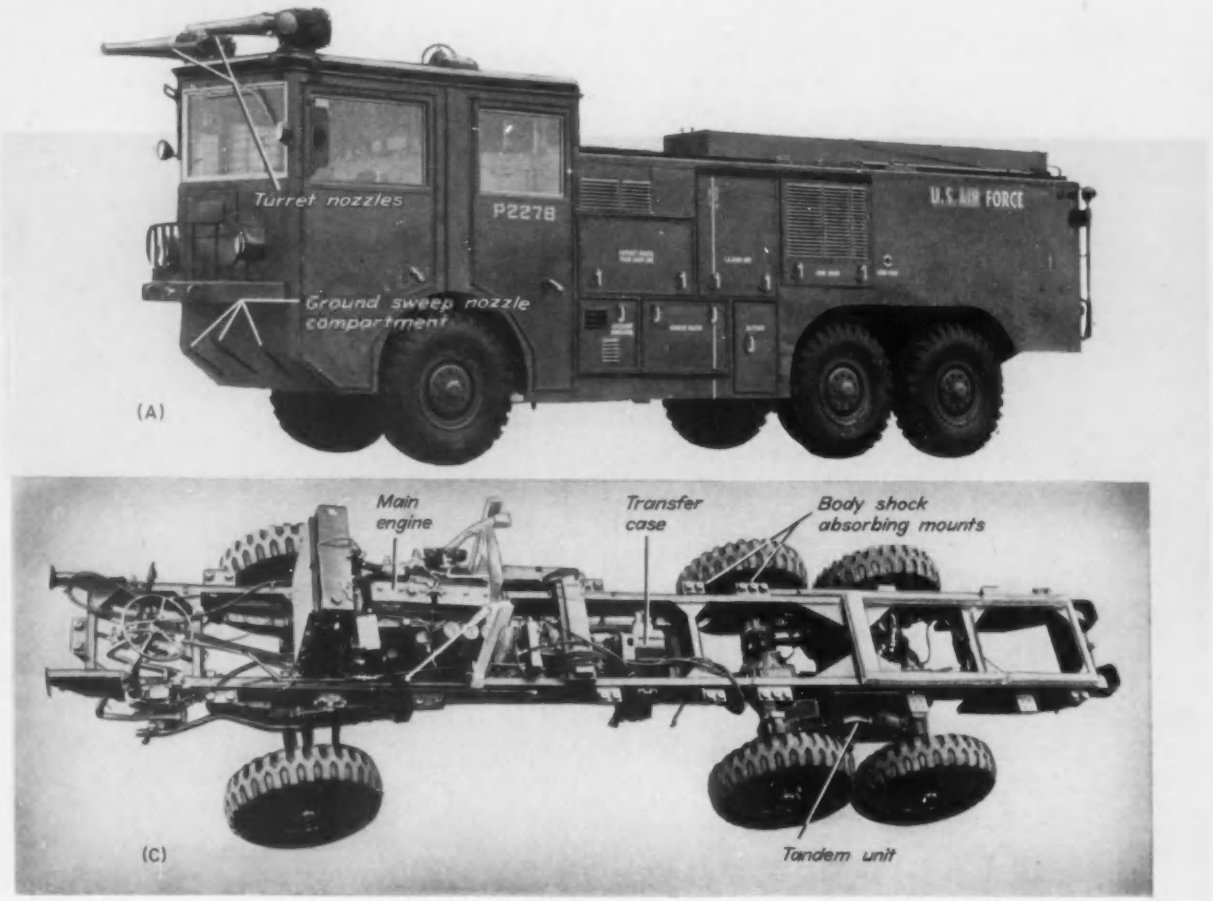
German Lathe (continued)

ENGAGING AND DISENGAGING, braking and reversing of the work spindle are all controlled by one lever. Movement of the lever closes an electrical circuit to the solenoid valves which are shifted to direct the hydraulic fluid to apply pressure to various clutches. Depending upon lever direction, the clutches are engaged to brake the spindle or release it from the drive. When the work spindle is reversed, the unit is first braked and then released before the motor is reversed.





A subject receiving increasing attention of late is the rapid growth in the importation of German machine tools into this country. With an eye to the steady decline of orders now on the books of American concerns, the German machine tool companies have been quick to point out their aim at the U. S. market. The area in which they plan to concentrate their efforts is that where skilled labor—not material—makes up the greatest part of the product. For this reason, they say, the high precision tools now under design will complement, not compete, with America's mass produced line.

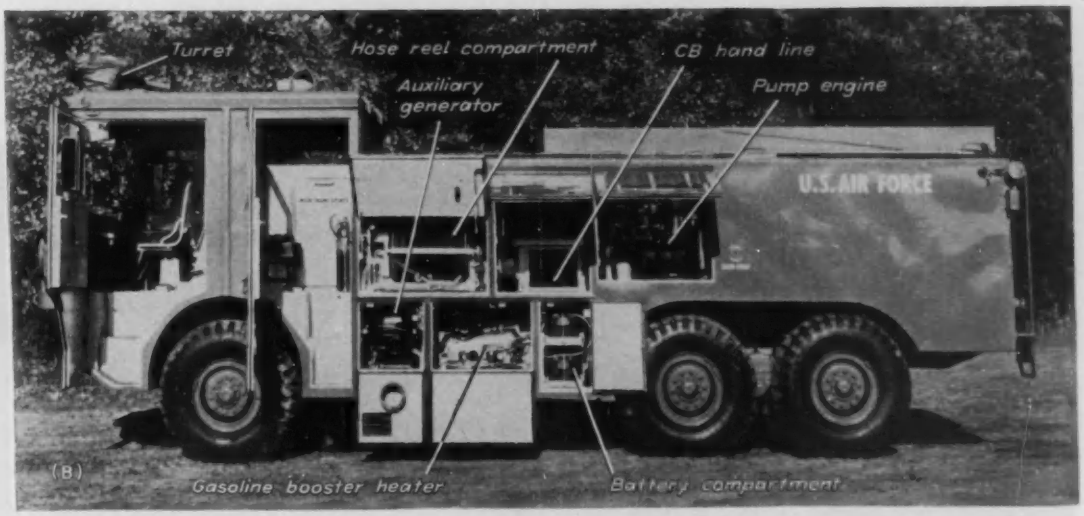


Newest Air Force Crash Truck Features

The latest word in self-contained fire fighting equipment, a crash, fire and rescue truck capable of operating under temperature conditions ranging from —65 to 130 F, is now under production by American-LaFrance Foamite Corp., Elmira, N. Y. for the U. S. Air Force. Weighing just under 42,000 lb and measuring over 30 ft long, 12 ft wide and 11 ft high, the new vehicle can accelerate from a standing start to 55 mph in 67 seconds. At the scene of a crash, the truck is equipped to pour out with pin-point accuracy better than 500 gpm of the most effective fire fighting agents yet developed.

With the gross weight and size rigidly restricted to permit air transportation by available cargo carriers, the design emphasizes maximum mobility and dependable controls. To load the truck with as much high performance fire fighting equipment as possible and still keep the overall weight down, aluminum was extensively used in the construction. The body is fabricated from riveted aluminum sheets and secured to the vehicle frame on bonded rubber shock mounts. Also of aluminum construction is the large water tank in the rear of the truck, the tank weighing approximately 1/3 that fabricated by conventional steel design. All non-skid plating on the truck is also aluminum pointing up another substantial weight savings.

To permit operation in sub-zero as well as tropical areas, the truck is insulated with a 2 in. thickness of fiberglass on the sides, top and floors. Interior partitions and the operator cab's floors and panels have a 1 in. insulation thickness. Glass used in the cab windows and doors is the double safety pane type with an air space between the panes. Side and rear windows are dehumidified and sealed, the air space in the other windows being used to allow induction of hot air for deicing or de-



(A) Aimed at isolating personnel from fire in a crashed aircraft—90 sec being considered as the maximum time to reach the scene and isolate the crew, the new truck has a fire fighting effectiveness of only 2 minutes. Because of the critical time period, the vehicle is manned by a 5 man team to insure reaching its optimum condition within the shortest possible time.

(B) Left side view of the crash, fire and rescue truck shows the "compartmented" design used in the construction, each major operating unit being located in separately enclosed spaces for maximum accessability. Complete control over the truck operation and its associated fire-fighting equipment is centered in the operator's cab, manned by 3 men.

(C) View of completely welded steel chassis before mounting of the body. To use as light a frame as possible, the frame rails are fabricated with material projections wherever strengthening members are attached. This design not only permits welding without a subsequent anneal, but also eliminates the need to use heavier frame rails to minimize welding stresses.

Instantaneous Fire Fighting "Punch"

frosting. The heating system is interconnected with the engine cooling system and is used as a cooling arrangement in high operating temperatures and as a heating system during cold conditions. Heat required is supplied by a gasoline fired booster heater which obtains its fuel from the main fuel tank of the truck.

Mobility is obtained with a 5 speed transmission powered by a 6 cylinder liquid cooled engine capable of developing 310 hp at maximum output. Drive is transmitted through a 2-plate, dry disk friction clutch, the transmission and a two-speed synchromesh transfer case to propeller shafts driving the four rear wheels and the two front wheels when necessary. During normal operation, the front drive axles free wheel. When the rear wheels lose traction, an over-running Sprag unit on the front output shaft engages the two front wheels into the overall drive system.

The firefighting equipment consists of both a foam type system and a chlorobromomethane (CB) system, both of which can be operated together or individually. Power for the foam system is supplied by an 8 cylinder, air-cooled horizontal engine developing 220 hp, the directly driven discharge pump drawing a water and foam solution from a special tank and discharging the mixture through a system piping. The foam equipment serviced by the pump consists of two roof-mounted turret nozzles, three ground sweep and two undertruck nozzles and two hose reel assemblies all mounted on the truck body. The truck is also equipped with a CB system which is primarily used because of its high effectiveness over a wide temperature range. A stainless steel tank located in the mid-section of the truck is charged with 40 gal of the liquid at 200 psi air pressure.

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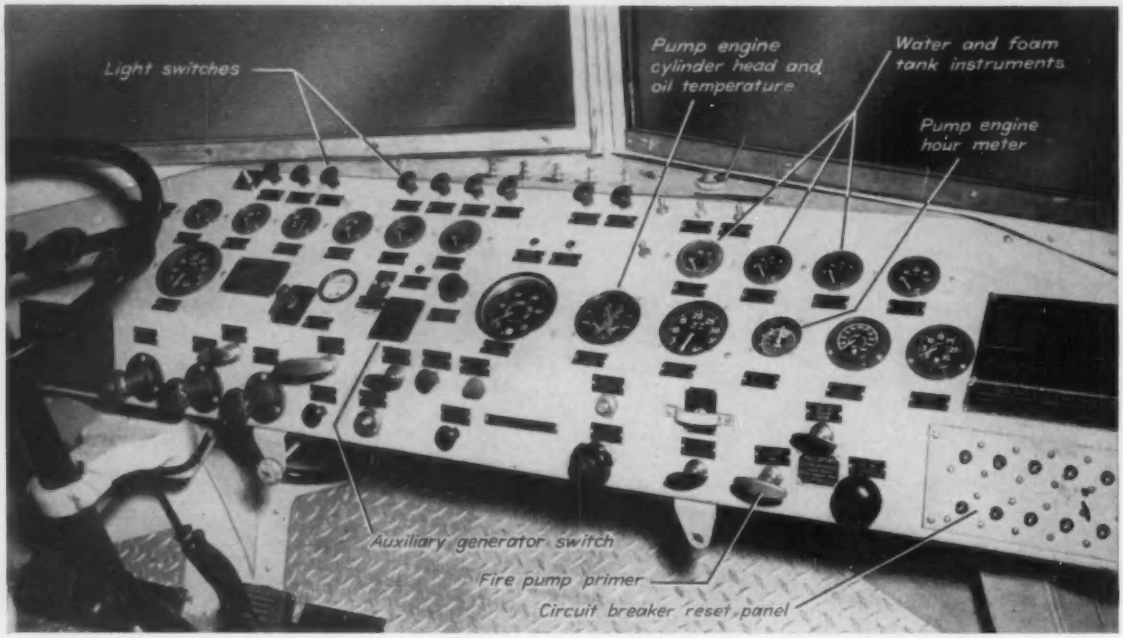
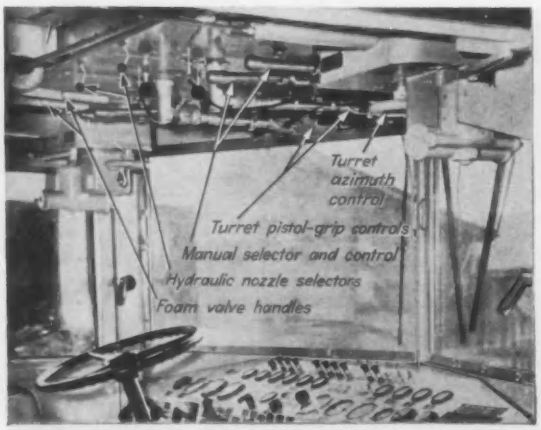
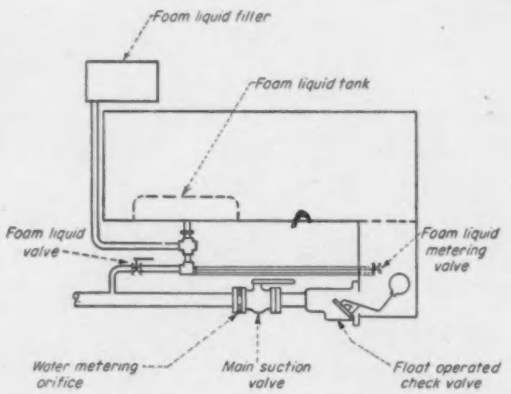
Air Force Crash Truck (continued)


Light switches
Pump engine cylinder head and oil temperature
Water and foam tank instruments
Pump engine hour meter
Auxiliary generator switch
Fire pump primer
Circuit breaker reset panel

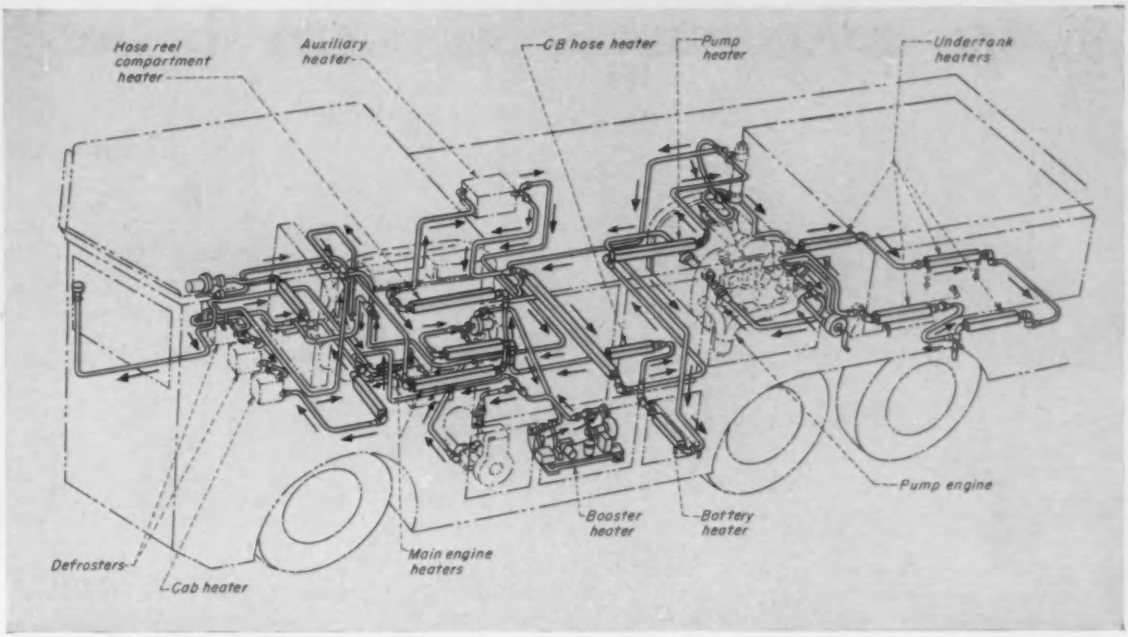
LOOKING MORE LIKE the instrument board of a modern aircraft than that of a crash truck, the vehicle's instrument panel contains all the instruments and controls necessary for complete centralized operation. Among the controls shown is the fire pump primer, connected to a valve in the pump engine exhaust line and used to redirect the exhaust flow through a venturi section. Flow through the venturi creates a vacuum in the pump suction line to effectively prime the pump. Also shown are the controls for the gasoline engine driven auxiliary generator.



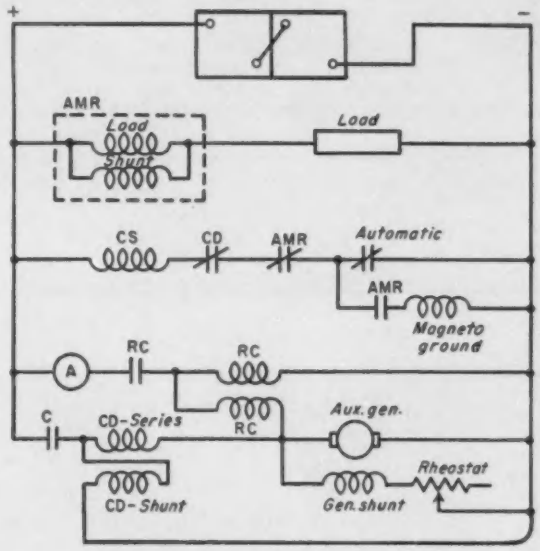
TWO TURRET NOZZLES mounted on the cab roof directly above the operators are hydraulically or manually controlled from inside the cab, or manually controlled from the roof. The hydraulic servo system permits the turret nozzles to be controlled and directed accurately, quickly and easily. "Joy-stick" controls extending downward from the ceiling aim the turrets, the position of the pistol grip being in phase with turret direction. Foam discharge is accomplished hydraulically by a push-button "trigger control valve."



PROPER RATIO of foam liquid to water during all phases of fire fighting is achieved by a dual suction proportioning system. The foam liquid is contained in a flexible rubber tank bolted to the inside bottom of the water tank, and is metered into the system with the foam and water combining in the pump suction. Since the two liquids are always under the same static head, they both feed into the suction piping in proportion to the effective area of their respective metering orifices.



VEHICLE'S HEATING and cooling system is built around a 90,000 Btu gasoline booster heater which is designed to automatically operate whenever the coolant temperature drops below 180 F. Coolant heated by the booster unit is circulated through the two engine compartments, cab heaters and defrosters. Also, the coolant is piped to a heat exchanger through which the tank water is circulated. This arrangement serves to transfer sufficient heat to the foam-water tank piping system to prevent freezing of the water in the tank and piping in sub-zero temperatures.

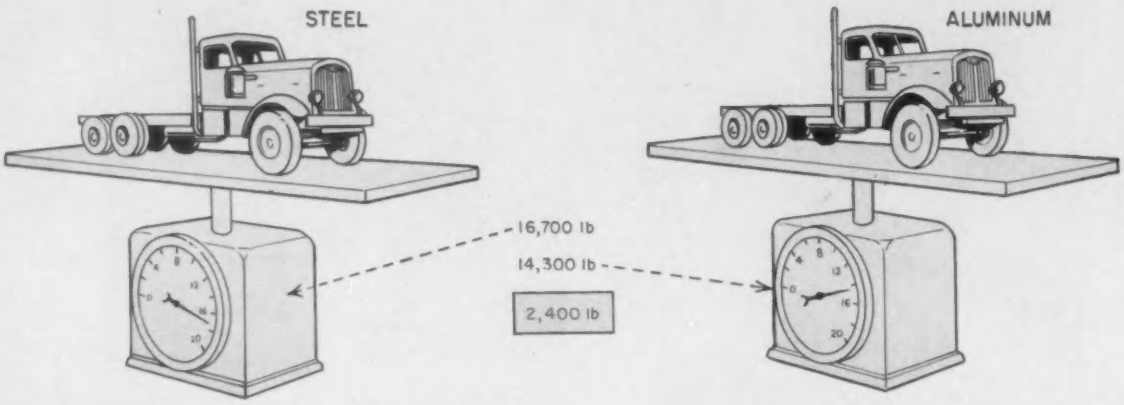


Relay Legend

AMR – *Automatic Master Relay*
CS – *Crank Solenoid*
CD – *Crank Disconnect*
RC – *Reverse Current*

TWO-WIRE DIAGRAM of the auxiliary generator circuit explains the automatic operation of the gasoline engine driven generator set to charge the batteries whenever the battery load exceeds 20 amps or voltage drops below 23.5 volts. The sensing or actuating component in the system is the master relay which has a load coil in series with the battery load and shunt coil across the battery terminals. Whenever one of the two conditions noted above occurs, the appropriate coil in the master relay operates the relay contacts de-energizing the engine magneto ground circuit. This action energizes the cranking circuit which, in turn, applies current to the generator causing it to run as a motor and start the gasoline engine. As soon as the engine begins to operate and drive the generator, a cranking disconnect relay opens de-energizing the starting circuit. A reverse current relay closes and directs the current flow into the batteries. When the battery charge reaches a predetermined figure, the master relay coil reverses the contact positions, grounding out the engine magneto.

Aluminum Replaces Steel to Boost



PAYLOAD—the trucking industry's formula for success—is given a 2,400 lb boost in Autocar's newly designed lightweight Diesel tandem tractor. Translated into dollars and cents, this weight reduction gives long distance truckers a real revenue bonus without edging closer to maximum wheel load regulations.

FACTORS IN TRUCK REDESIGN

Concept—State regulations place a definite limit on truck wheel loads. To boost payloads without any net increase in overall weight, lightweight alloys replace standard heavier construction without sacrificing strength or durability.

Materials—High tensile strength ferrous and nonferrous alloys are selected as first step in redesign program to replace heavier steel construction.

Tooling—Tooling costs are kept practically negligible since existing tools are simply modified for use with new materials.

Problems—Biggest problem arises in training workers to work with new materials, and mastering necessary metal joining techniques.

Cost—Because of slower and more critical joining methods when using aluminum as compared to steel, assembly time for the same construction units increases. But principal cost rises result from use of higher priced lightweight alloys.

Electronic Unit Uses Mechanical Principle

Operation of a device developed by Minneapolis-Honeywell Regulator Co. to detect the time deviation between the frequency of a power source and that of a standard, is based upon a differential spider gear arrangement. Measurement of the deviation is made electronically, both means combining to give an overall accuracy of $\frac{1}{4}$ percent.

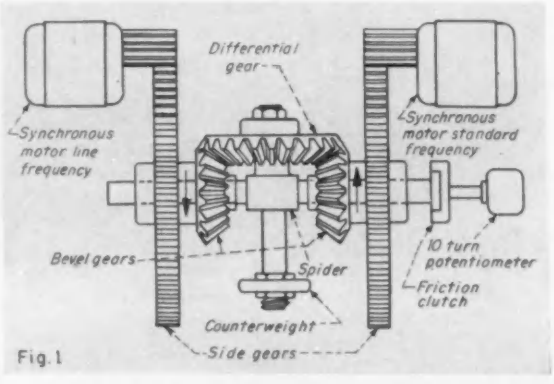


Fig. 1

Truck Payload

Breakdown of Weight Reductions

Items Affected	Weight Saving, lb
Wheels, chassis cross-members, transmission cases and covers, axle housings and hubs, front bumper	1,800
Cab frame and panels	254
Misc. chassis and engine parts	124
Step tank, running boards	91
Battery box	73
Hood	34
Cab hardware	15
Floorboard and parts	9
Total	2,400

ONLY STRUCTURE DIFFERENCE between the aluminum and steel cab frames are the aluminum castings (A) to which the windshield is attached and the supporting cross members (B) used at the lower corners of the cab sill. On the steel frame, these points are welded. Otherwise, no additional strength members are required in aluminum design.

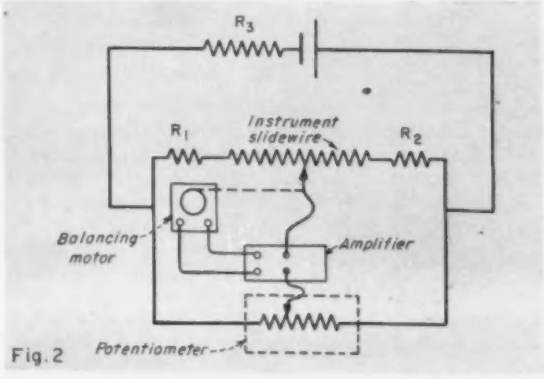


Fig. 1—Two synchronous motors are used, one driven by the supplied power source, the other by an accurate source of standard frequency. When the two frequencies are equal, both bevel gears rotate at the same speed and in opposite directions with the floating spider take-off shaft remaining stationary. When frequencies differ, the spider rotates about the axis of the bevel gear shafts at a speed proportional to the difference between the frequencies.

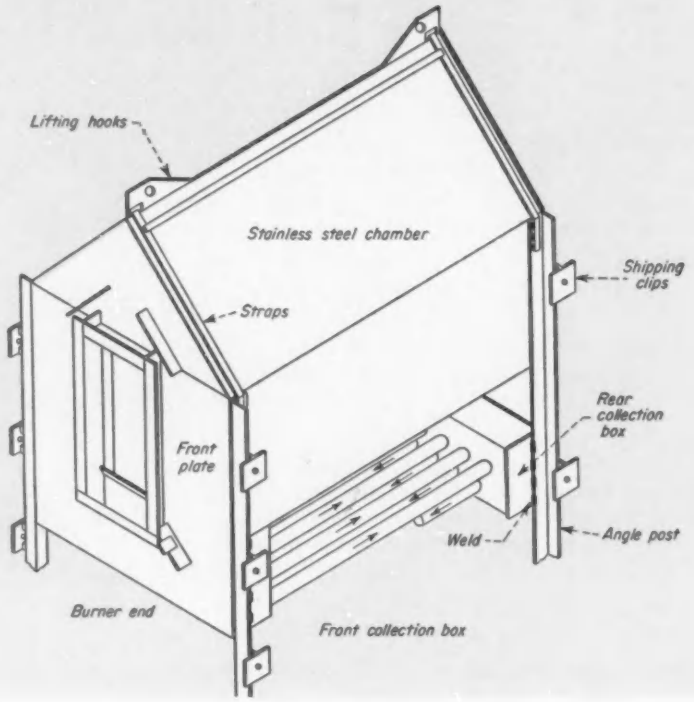
Fig. 2—Take-off spider shaft is connected to a slidewire contactor of a potentiometer. As contactor moves, potentiometer becomes unbalanced and a signal is placed on an amplifier. This energizes a balancing motor which moves the contactor until balance is restored, the point of balance being the time differential.

"Floating" Heater Combustion Chamber

The latest step in the design of Dravo Corporation's stainless steel combustion chamber for their space heating units (see *Product Engineering*, March 1946, p. 96) is a new method of mounting which eliminates the heater shipping and installation problems and adds to the service life of the chamber.

New design points up a considerable reduction — compared to the older construction — in the amount of welding of low carbon to stainless steel. Also, new mounting leaves one end of the chamber free to expand and contract with heating loads, thereby minimizing possibility of metal buckling. Another change is the installation of shipping clips on the four angle posts instead of being welded to the sides of the chamber. This feature permits the clips to be left in place after shipment, their permanent mounting not interfering with the chamber's freedom to expand or contract.

ISOMETRIC VIEW of stainless steel combustion chamber shows "floating" design. To permit free movement at one end regardless of the position in which the heater is mounted, the chamber uses steel straps as the main positioning members. The chamber is welded to the front plate and collection box with the four angle posts extended to the top break of the chamber. Steel strapping is then run from the posts around the chamber. In an upright position, the heater is supported by the tube collection box; when inverted, it is supported by the straps. The chamber is free to move on the rear collection box to relieve any stresses or strains set up during heater operation.



Automatic "Color Carousel"—Latest Concept in Paint Merchandising

A new type paint mixing machine—essentially a device for the precise volumetric metering of tinting pastes—has been recently developed to free the retail paint dealer from the necessity of stocking a large number of colors and sizes of cans of paint. Designed by Raymond Spilman, Industrial Designer, for Standard-Toch Chemicals, Inc., Staten Island, N. Y., the machine requires only twelve tinting pastes and three paint bases for production of an unlimited range of colors. The tinting pastes are contained in one gal reservoirs in a drum type turret, paint bases in different size cans are held in stock.

Here's How It Works—When the customer selects a color from a display chart, each color being coded for the pastes used in the formulation and the base required, the dealer merely transfers the coded information to machine dial settings. The turret indexes according to the electrical circuit set up by the dial settings and a timer actuates a solenoid valve at each index to allow the correct amount of paste to be pumped into the stationary positioned can. At the conclusion of the timed period, the solenoid is de-energized and the metering valve is closed, the turret indexing to position the next paste reservoir over the can. Dispensing accuracy is 0.01 oz which is well within color card matching limits.

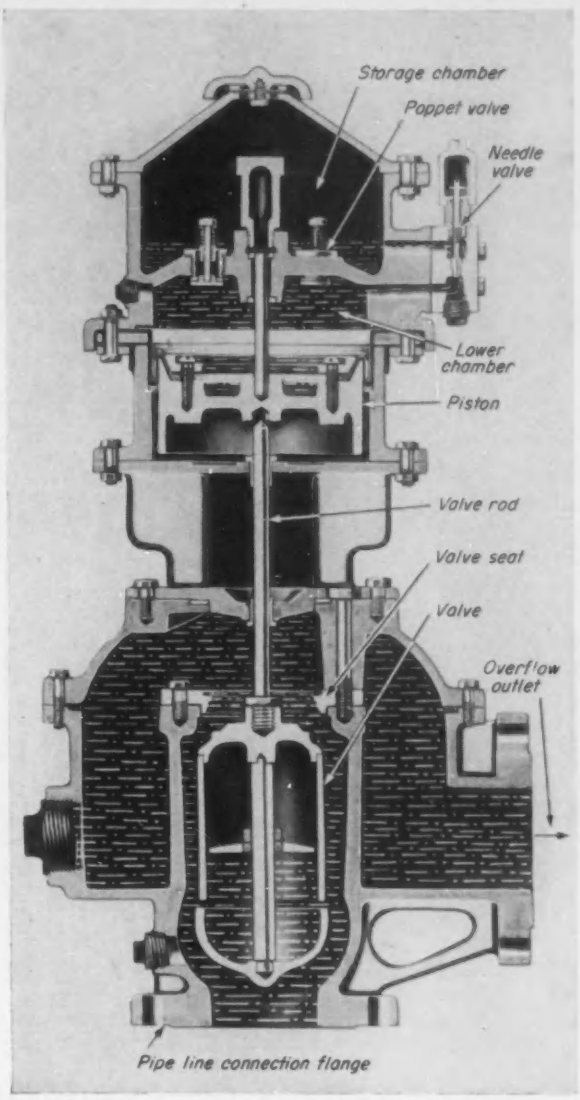
Controlled Closing Valve Prevents Pipeline Surges

Regulating the closing rate of an air release valve through an adjustable needle valve arrangement forms the basis of the design of a new controlled closing valve recently developed by the Simplex Valve and Meter Co., Philadelphia, Pa. Particularly useful for large and long pipelines being filled for the first time, the valve is aimed at protecting the line and it fittings against the damaging effects of surge and water hammer.

Valve closing is controlled by movement of a piston in contact with the valve stem. Above the piston and sealed in by a controller type rolling rubber diaphragm is a quantity of retarding fluid, the upward pressure of which keeps four spring-loaded poppet valves tightly closed. Passage for the fluid from the lower to the upper portion of the retarding chamber is through an adjustable needle valve. Thus, by regulating the opening of the needle valve, the closing speed of the valve can be closely controlled.

An additional function of the valve is as an inlet or vacuum-breaking device. Should a line break occur with rapid drainage resulting in a vacuum being formed in the line, the valve loses its buoyancy and falls to a lower position. This action admits air into the line, destroying the vacuum and preventing collapse of the pipe. When the valve drops, piston pressure is relieved allowing the retarding liquid to drain through the poppet valves into the lower chamber. Thus, the valve is again ready for the filling operation.

Installed, the valve is bolted to a standard flanged fitting in the line with the rate of valve closure adjusted for the particular operation.



OPERATION. As the line is being filled with water, air contained in the pipe line is discharged and when this operation is completed, water enters the valve casing and attempts to float the valve to its seat. Closing motion of the valve is transferred by a vertical rod to a block at the bottom of a piston, any rapid movement being prevented by the retarding liquid in the chamber. Increased pressure by the piston forces the liquid through a needle valve into a storage chamber until sufficient liquid has been displaced allowing the valve to seat and thereby sealing the line.

***NEXT MONTH'S PRODUCT DESIGNS** will feature one of the most talked about assemblies of ingenious mechanisms with which the public has recently come in contact, that of the automatic pin setting machine for bowling alleys. Also to be included in the next issue's coverage are: A hydraulically-operated nut torquing machine, study of a centralized lubrication system for fork lift trucks, and a wheel tractor that is both air compressor and tractor.*

Installation Torque vs Stress in Standard AN Bolts

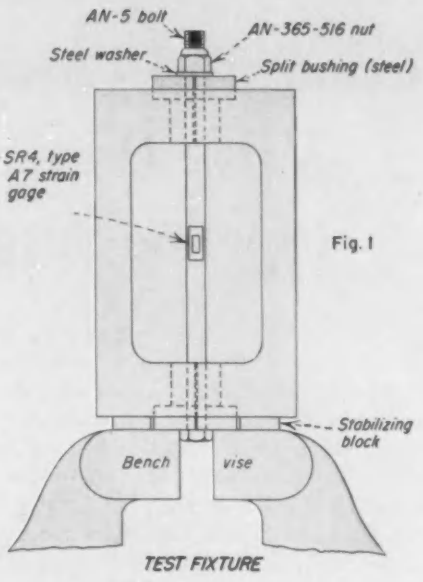


Fig. 1

An evaluation of recent tests made to determine the correct amount of torque necessary to produce the expected bolt stress. Both dry and lubricated standard AN bolts and nuts were used.*

VALUES OF TORQUE versus bolt stress at 40,000 psi as listed in the "Handbook of Instructions for Aircraft Designers"[1] have been generally used to preload tension bolts in aircraft assemblies. Since the fatigue life of such an assembly is closely related to the amount of pre-load existing in the bolt, it is of prime importance that installation torques produce expected bolt stresses.

Lockheed[4] tests indicate that investigation on small size bolts show "HIAD"[1] dry torque values recommended for 40,000 psi bolt stress in reality give 20,000 psi. The same report also shows that when the same size bolts were investigated with lubricated threads, 40,000 psi bolt stress was obtained with the listed dry torque values.

Three diameters of AN bolts, $\frac{1}{4}$, $\frac{5}{16}$ and $\frac{3}{8}$ in., were used in the tests, with AN-365 lock nuts, the fiber insert type, used initially, and AN-310 castellated nuts used for further investigations. Fig. 1 shows the equipment used.

Readings were taken at increments of 20 in. -lb. torque up to about 80,000 psi stress in the bolt shank. On each bolt there were two runs made with the same nut to observe the difference when using fresh nuts as against pre-used nuts. This applies to both the "dry" and lubricated tests. The lubricant used was SAE 1120 engine oil.

All the data collected represents the initial stress condition, where the torque was brought to a pre-determined value and then held until the strain was read. No readings were taken in the steady, relaxed, stress condition which would result after removal of wrench pressure. The strain readings were converted to the stress values based on the bolt shank diameter where the strain gages were located. These values do not represent however, the highest stress developed in the bolt—that which occurred in the threaded portion. The data were then converted to indicate the average stress based on the root diameter of the threaded portion of the bolt. Fig. 2 represents a typical plot of recorded bolt stress versus nut torque for the various runs both dry and lubricated, utilizing AN 4 bolts with AN 365 nuts.

Several consistent features were noticed during the tests. On both the AN-310 castellated nut and AN-365 lock nut types, it was noticed that the initial run with fresh parts (dry) required lower torque to produce a given

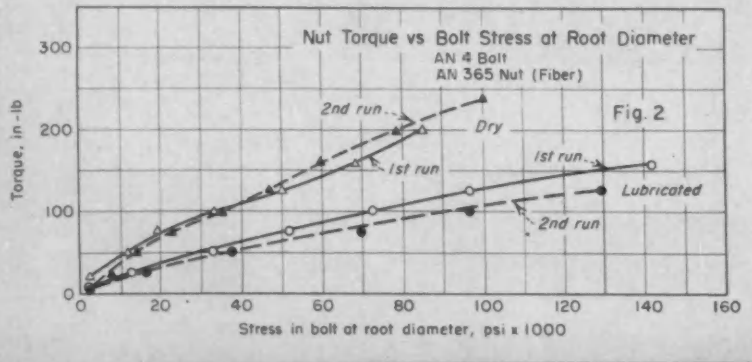


Fig. 2

*Material gathered from tests by Glenn L. Martin Co.

stress than that required for the second run. This may seem to be rather unusual, especially with fiber insert nuts (AN-365), which must be tapped through the insert on the initial run. However, results show that the same is true regardless of whether or not the fiber insert was present, indicating that the fiber was not responsible for the lower torque on the first run.

The reason for this is not immediately apparent, but there is reason to believe that the cadmium plating on the threads was abraded and lifted by the metal-to-metal contact with the nut threads, thus "clogging" the small bearing areas between the nut and bolt threads and causing a frictional increase. Since it was found on both types of nuts (AN-310 and AN-365), it was assumed that it was entirely due to metallic contacts.

On lubricated installations, the opposite of the above occurs. Naturally, much lower torques are required to produce a given stress when lubricated than when dry. The second run (lubricated) requires the lower torque; exactly the opposite of that which takes place in dry installations. This, too, is fairly regular for all sizes and regardless of the fiber insert. It is possible that the minute particles of disarranged plating are not present as much in this instance due to lubrication and decreased stresses involved. It is also possible that the lubricant tends to wash away these particles toward the outside of the nut. Visible evidence of damage to the plating was present on the bolts but no specific agglomeration of these particles was noticed outside the nut.

Another possible explanation of the phenomenon is that the threads in both bolt and nut are distorted to some degree by the first run. Since stresses were based on bolt shank diameter, it is obvious that in some cases yield was exceeded, if and when the root diameter is considered in computing the critical area.

Table I presents a comparison of "HIAD" torque data for the particular sizes tested, based on their torque values for 40,000 psi bolt tension. The dry torque test values are consistently much higher than those quoted by "HIAD", and the lubricated test torque values are in the range quoted for dry installations.

It is interesting to note that in previous Martin tests[3] conducted for pur-

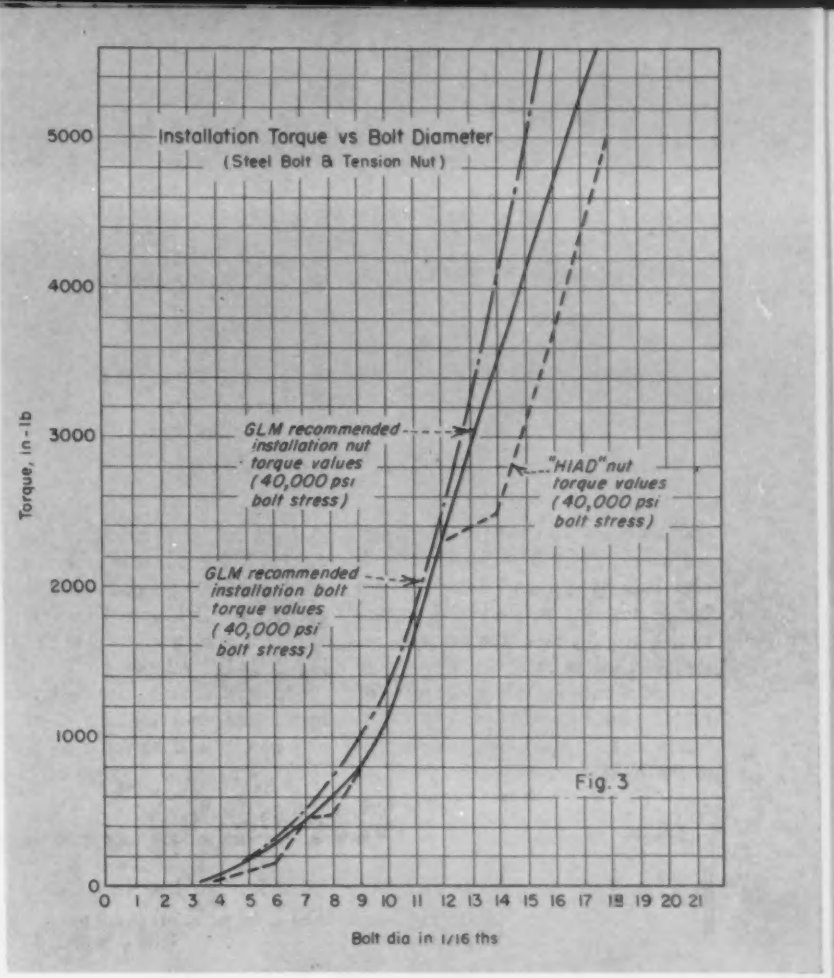

Installation Torque vs Bolt Diameter
(Steel Bolt & Tension Nut)
GLM recommended installation nut torque values (40,000 psi bolt stress)
"HIAD" nut torque values (40,000 psi bolt stress)
GLM recommended installation bolt torque values (40,000 psi bolt stress)
Torque, in-lb
Bolt dia in 1/16 ths
0
1000
2000
3000
4000
5000
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Fig. 3

Table I—Comparison of Test Results to "HIAD" Torque Values
Cadmium Plated Threads—Class III Fit

	HIAD Torque for 40,000 PSI (Nut Torque) In.-Lb.	Test Value for 40,000 PSI Dry (Nut Torque) In.-Lb. (1)		Test Value for 40,000 PSI Lubricated (Nut Torque) In.-Lb. (1)		Max. Allowable Torque 90,000 PSI HIAD
	AN-365 & AN-310	AN-365	AN-310	AN-365	AN-310	
1/4-28	50	95 115 110 110 (2)	78 90	65 55 65 55 (2)	50 38	100
5/16-24	100	192 ... (3) 196 265 (2)	115 185	128 118 200 265 (2)	95 73	225
3/8-24	160	375 420 325 445 (2)	210 220	195 170 200 180 (2)	175 160	390

Note (1) Upper figures represent first runs: lower figures are second runs
(2) Complete retest values.
(3) Bolt failed on first run.

poses of determining nut effects on stud fatigue life, it was necessary to accurately determine the amount of pre-load in the stud caused by torque applied to the nut. This was accomplished by prior calibrations and preparation of nut torque versus bolt stress curves. The results proved similar to those in Table I for the dry condition at 40,000 psi bolt stress, although the method for calibration differed.

Table II lists "HIAD" recommended dry torque values supposedly representative of 40,000 psi bolt stress, together with maximum allowable torque values supposedly representative of 90,000 psi bolt stress. It also lists Martin and Lockheed nut torque test values, Lockheed process values, and the new recommended installation values based on all available considerations including a plot of torque values vs bolt diameter to insure a smooth curve from size to size as shown in the accompanying Fig. 3.

The new recommended values for 40,000 psi bolt stress, do not exceed the maximum allowable torques (either nut or bolt torques) as listed in "HIAD", do not recommend nut torques exceed 56 percent $\left(\frac{0.67}{1.20}\right)$ of minimum failing nut torques as determined on previous tests.[2]

Table II reveals that caution has been exercised in establishing the new recommended installation values to guard against premature bolt or nut breakage resulting from their use. The variables involved as previously noted will not permit a guarantee that new recommended values will, in all cases, produce 40,000 psi bolt stress; but the chances of obtaining 40,000 psi are much better than with use of the existing "HIAD" values.

New torque values for steel nut and bolt installations utilizing shear nuts may be obtained by using 60 percent of the recommended values for installations using tension nuts. This is in line with "HIAD" recommendations.

Installation torque values for aluminum alloy nut and bolt installations (for about 20,000 psi bolt stress) may be established by using 50 percent of the recommended values for steel nut and bolt installations.

If torque values other than those equivalent to 40,000 psi are required for steel bolt-nut combinations, a straight line ratio to determine such torques is recommended.

REFERENCES

1. Handbook of Instruction for Aircraft Designers, published by Air Research and Development Command, Baltimore, Maryland.
2. Glenn L. Martin E.T.R. 948—"Some Ultimate Torque Tests AN & UAB Nut-Bolt Combinations," February 10, 1949.
3. Glenn L. Martin ER No. 4824-9, "A Comparison of The Effect of AN-365 and Thin Light Weight Steel Lock Nuts on Stud Fatigue Life."
4. Lockheed Report No. 7010 — "Torque Tests of Several Types of Nuts —Dry and Lubricated."

Table II—Torque (In.-Lbs.) Values for Standard Steel Tension Nuts and Bolts with Dry Threads

(Where two values appear, the 1st. refers to nut torque and the 2nd to bolt torque)

(1) Bolt Size	(2) "HIAD" Recommended Installation Torques 40,000 psi Bolt Stress	(3) "HIAD" Max. Allowable Installation Torques 90,000 psi Bolt Stress	(4) Nut Torque Torque-Min. Failing GLM Test Values[3]	(5) Nut Torque 56% of Column 4 $\left(\frac{0.67}{1.20}\right)$	Nut Torque GLM Test Data for 40,000 psi[2]	Nut Torque Lockheed Test Data for 40,000 psi[4]	Lockheed Standard Process Installation Torques	New Glenn L. Martin Recommended Installation Torques
10–32	20–25	40	76	42	.....	52 (1) 32 (2) 30 (3)	25–40	30–35
1/4	50–70	100	135	75	115 (2) 78 (3)	129 (1) 135 (2) 147 (3)	70–100	75–85
5/16	100–140	225	425	236	217 (2) 115 (3)	232 (1) 250 (2) 207 (3)	140–225	190–200
3/8	160–190	390	630	350	375 (2) 210 (3)	410 (1) 325 (2) 385 (3)	190–290	300–330
7/16	450–500	840	470 (Bad Nuts)	261 (Bad Nuts)	.....	.....	450–500	450–500
1/2	480–690	1100	1400	790	.....	670 (1) 840 (3)	480–690	600–750
9/16	800–1000	1600	1100 (4)	610 (4)	.....	.....	800–1000	800–1000
5/8	1100–1300	2400	2160	1205	.....	1700 (1) 1800 (3)	1100–1300	1100–1300
3/4	2300–2500	5000	3950	2200	.....	2600 (1) 2750 (3)	2300–2500	2300–2500
7/8	2500–3000	7000	7200	4000	.....	.....	2500–3000	3500–4000
1	3700–5500	10000	....	....	.....	.....	3700–5500	4650–6000
1-1/8	5000–7000	15000	....	....	.....	.....	5000–7000	5800–7800
1-1/4	9000–11000	25000	....	....	.....	.....	9000–11000	9000–11000

(1) Average value for segmented top or slotted collar lock nuts.
(2) Average value for non-metallic insert lock nuts.
(3) Average value for castellated lock nuts.
(4) Looks out of line.

Should Current DRAFTING PRACTICES *Be Further Simplified?*

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Dean Gerardi has studied drafting practices closely while serving with many technical groups. A member of SAE's Automotive Drafting Standards Committees since 1948, he has also served on the American Standards Association's Executive Committee on Drafting Standards (ASA-Y14) and as chairman of the Engineering Drawing Division, American Society for Engineering Education.

DURING THE PAST YEAR an effort to simplify drafting practices has been made by a small group of industrialists representing only one of many American industries. The objective – reduced drafting room cost.

In contrast, several American industries have been engaged in a thorough study of existing drafting practices. The project was reactivated in 1945 and will continue. It requires the services of several hundred engineers and their assistants, not including the personnel involved in similar activities which are presently under way in England and Canada. Their objective – elimination of confusion, establishment of uniformity of graphical expression, and eventually national as well as international drafting standards.

A book, "Simplified Drafting Practices," by Messrs. Healy and Rau of the General Electric Company staff, has been published and distributed in the United States and England. In this text the authors promote increased use of freehand sketches for working drawings and elimination of nonessentials and frills. They support the claim that their principles and techniques can save industrial drafting time by as much as 50 percent. The Radio Corporation of America has also embarked on a somewhat less ambitious program of simplification, but hopes to intensify its program as the chief draftsmen accept these practices. Editors of engineering magazines, both here and abroad, latched on to the idea and extolled the courage of pioneers who advocate these new and extreme methods in drafting.

The British publication "Engineering" goes to great length to encourage use of one-view drawing, freehand sketching, codes and symbols, and in the November, 1953 issue editorializes, "Simplified drawing is already universally accepted in, for example, the use of conventionalized-oblique lines for screw threads." It is evident that the editor does not realize that the use of this symbol for threads was frowned upon by American industry years ago. The editor then continues, "The book gives examples of drawings which have been prepared by the old and the new methods. The difference is remarkable, and makes it quite clear that the changes recommended, based on practical experience of it, is a fundamental change rather than a slight modification to existing practice."

Mr. Norman Stubbs, editor of "Machinist," a technical magazine published in London, takes an entirely different point of view. In an editorial dated January 2, 1954 he questions the claims made by American and British proponents of simplified practices and goes to the heart of the problem by expressing it thus: "Nobody, presumably, would contest the contention that drawings should be reduced to their essentials." He suggested that where argument has arisen it has been, and will continue to be, in the determination of what is essential. He continues, "And to the criticisms already referred to, may be added the doubts expressed as to the time actually saved, the degree of simplification advocated, and the risk of misinterpretation of the draughtsman's intentions."

Savings in time, money, and material are not the only reasons given to advance the cause of simplification. It is claimed that time saved by the draftsmen can be devoted to creative thinking. This might be true if the draftsman is the engineer, but in most industrial organizations, large or small, a person classified as an engineer devotes his time to research, computational design, and development of a product. The drawings he may prepare are incidental to the design, often merely freehand sketches, and usually not intended for distribution to the shop or the supplier. It is the prime responsibility of

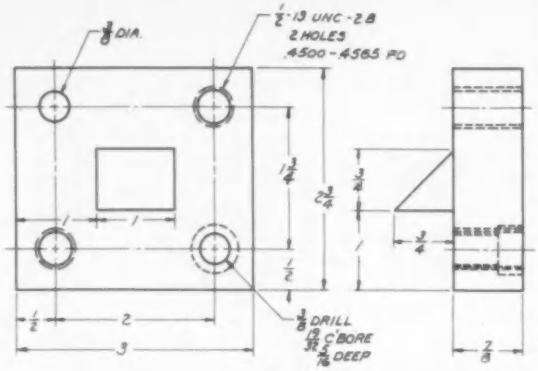
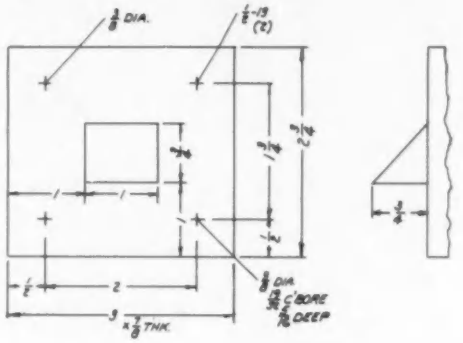


Fig. 1 — Normal drafting practice is to show holes as circles in the plan view and dotted lines in the side view. Dimensioning uses arrow heads.

Fig. 2 — Simplified drafting may or may not use arrow heads, does not visualize holes, and shows a minimum of views.



draftsmen to convey in unmistakable terms the intentions of the designers. A draftsman cannot be expected to make drawings, satisfy the requirements of engineers, designers, checkers, and still have time left for creative thinking.

It must be remembered that in the early days of the industrial revolution drafting was an art. One could measure the draftsman's pride by the drawing he rendered. Fine lines, fancy lettering, ornate borders, and use of color in shaded drawings were the order of the day. As the revolution gained momentum, the demand for drawings became so great that fancy and artistic frills had to give way to simplicity. It soon became evident that the real purpose of a drawing was to convey information. Unfortunately no one concerned himself with the manner by which the information should be expressed. Since the value of the draftsman was measured by his ability to get the job done, no one gave thought to the amount of time wasted in the field or shop.

Simplification, during those days, seemed to give license to the draftsman to draw according to his whims. Confusion reigned! Some drawings were delineated in first angle projection, some in the third. Although some drawings were still works of art, some were so downright sloppy that hours had to be spent on interpretation. It didn't take long for industry to discover the high costs resulting from poorly executed drawings. No one wanted the fancy and artistic drawing, for it had been proved that plain line drawings, if properly rendered, were a great improvement over the works of art. Dissatisfaction, inefficiency, lack of uniformity resulted in a strong plea for clarification and standardization, but official action was not taken until 1926 when the American Standards Association, The American Society for Engineering Education, (at that time known as the Society for the Promotion of Engineering Education), and the American Society of Mechanical Engineers sponsored the organization of a sectional committee to develop American drafting practices.

It can be seen from this history that simplification was derived from standardization; let us not be hasty and presume, however, that the present effort towards further simplification will lead to better standards. The worn out phrase, "a picture is worth a thousand words," takes on new life in this instance. The drawing in Fig. 1 is made according to present acceptable practices and complies with existing standards acceptable to American industry. Fig. 2 represents a method of drawing and dimensioning the same part according to so called "simplified practices." Fig. 3 is also drawn according to "simplified practices" and includes a system of "arrowless dimensioning." In Fig. 4 is shown "simplified practice" drawing of a structural element. What is it? In Fig. 5, on the next page, is shown the same construction drawn in the generally accepted manner.

It is surprising that a few large, important, and enterprising industrial firms find it profitable to promote a "shorthand" such as shown in Figs. 2, 3, and 4. One would be tempted to assume that their draftsmen would display the same pride in their work as the companies claim for their products. Evidently this is not the case. One is tempted to ask a few questions. Do these organizations propose a double standard, one for the engineer who is responsible for the quality of the product he designs, and a different one for the draftsman who prepares the drawings and specifications? Have all the divisions of these corporations and, more important, industry as a whole, accepted these fundamentals of simplification? Furthermore, what is artistic, fancy, or meticulous about the drawings which are delineated as in Fig. 1 and 5? Should they be simplified, such as in Figs. 2, 3, and 4? Or would greater understanding result from further clarification of Fig. 1 or 5 to indicate the intent more specifically?

If a draftsman is inclined to be overly generous in the number of views he projects, or to be theoretical in the development of views, or too artistic in his lettering, would not a few words from his supervisor, calling attention to standard simplified procedure, be better than to encourage careless work? The tapped holes in Fig. 1 have all the necessary data regarding size, form, and tolerances of the threads shown. This notation and the simplified representation depicted by dotted lines are not time consuming and ornamental; but, more important, anything less could be misunderstood. Moreover, it is in agreement with the international agreement on interchangeability of threaded products. This "Declaration of Accord" which was signed on November 18, 1948 does not represent the opinions of a few people, but resulted from years of hard work by active committees composed of representatives from industry, producers, trade associations, and technical societies of three nations. Referring to Figs. 2, 3, and 4, can the same be said for the tapped holes shown there?

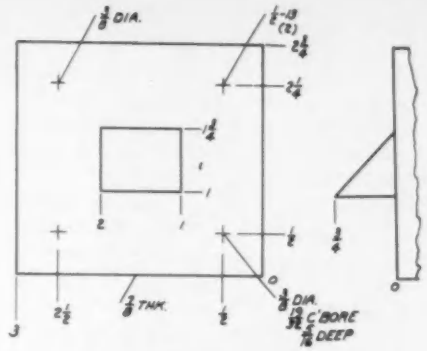


Fig. 3 — Simplified drafting also proposes the entire omission of conventional dimensioning. Locations and dimensions are designated by numbers that indicate distances from a datum line or origin point.

It is the purpose of this article to distinguish between simplification by omission and simplification by standardization. Ambiguity and misunderstanding often arise from a mistaken impression that simplification and standardization are synonymous. Simplification normally implies a restriction; that is to say that the draftsman will restrict the data he puts on the drawing according to its purpose. Certainly one-view drawings, freehand sketches, schematic diagrams, or any kind of draftsmen's "shorthand" can be resorted to when a new product or design is in its embryonic stages.

It might even be conceded that draftsmen can go hog wild and develop a drafting standard foreign to all existing standards if the product is designed and manufactured within a closely integrated organization, and provided further that the cost of training engineering and shop personnel in these practices can be justified. If, however, a product is designed and developed by one concern and its components manufactured in different parts of the country, the draftsman can not exercise the same degree of freedom. He may draw half-views to denote symmetry, and partial views for sections; he may eliminate dotted lines for invisible edges if clarity results. But he should not have license to eliminate views, crosshatching lines, circles for drilled or tapped holes, arrowheads etc., just to save time at the drafting board at the expense of those who will have to interpret the drawings later.

Standardization may or may not embody simplification It is concerned basically with the determination of the desirable methods of delineation, dimensioning, symbols, and other factors which enter into the rendering of a drawing. The objective is to produce drawings which cannot under any circumstances be misunderstood.

The true value of simplified or standard drafting practices should not be measured by the ability or energy of a few people who promote these practices within one corporation or even within a few divisions of a corporation, but rather by the extent to which they are accepted by a majority of various industries. A drafting standard could be a masterpiece or classic for a given industry and yet be worthless if it deviated from common practices to such an extent that a special drawing would have to be prepared every time equipment was used in a product manufactured by another industry. It might be argued that drafting standards satisfactory for all industries would become voluminous and undesirable. Experience proves otherwise.

General Electric and RCA are to the electrical industry as General Motors, Ford, and Chrysler are to the automotive industry. All of these organizations have been vitally interested in standardization. They are represented on national standards committees and employ standards engineers because *standards pay dividends*. Then why should drafting practices which have been refined over the years suddenly be classified as outmoded as the horse and buggy?

One is reminded of the drawing which Thomas Edison made in 1875 while he was developing his talking machine. The freehand sketch of his phonograph consisted of a pictorial view of a cylinder covered with a foil, a needle connected to the center of a diaphragm, and a crank mechanism for turning the cylinder. Symbols were used to represent the mouthpiece and the diaphragm. This drawing was completely devoid of details, sections, material specifications and dimensions.

Three words, "Kruesi make this," were the only instructions written on the drawing and constituted the authority by which his mechanic was to produce the phonograph. The date and Edison's name were the only other written words.

We all know that the phonograph was made. What no one can tell us is the number of times the mechanic had to see Mr. Edison or the time consumed in each of these conferences. We can assume, however, that Mr. Kruesi was a master mechanic, that the work was done in a room adjacent to Mr. Edison's laboratory, and that each had a perfect understanding of the principles and terminology involved in the project. There was no question here of mass production, suppliers, intricate machinery, cost, research, and the many other factors which must be considered today.

Mr. Edison was justified in making this freehand sketch.

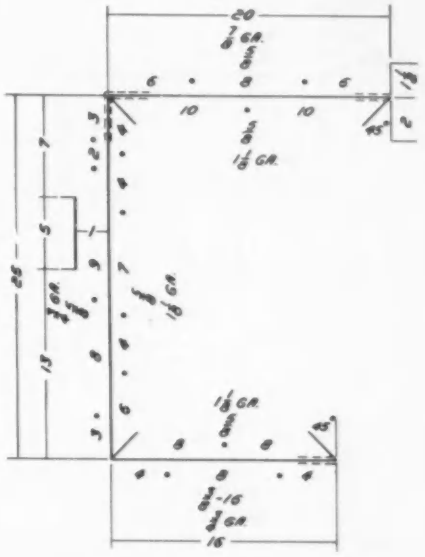


Fig. 4—This represents a typical ultra simplified drawing of a structural element. Only a few dimensions are given in the conventional manner but with arrowheads omitted. Holes are shown by dots and located by numbers and notations. What is this construction?

For the answer, turn the page.

Similar procedures are used in many design offices today, especially where the shop is an integral part of a research or engineering organization. One can be sure, however, that when Mr. Edison's phonograph was ready for mass production, the drawings had to be replete with detail.

Drafting standards do not come out of discussions by a few people who sit around a table with a philosophy that what is good for their companies is good for all industry. They result from an adequate discussion of the technological problems under consideration, the facts related to those problems based on experiences of qualified men, and sincere compromise. This is no less true in what is probably *the most difficult of all subjects, engineering drawing.*

Mr. William A. Siler, chairman of the Society of Automotive Engineers' Drafting Standards Committee, recognized the difficult task of producing drafting standards for the automotive industry and made this statement at the first meeting in April, 1945:

"If we are to achieve unity of thought in national standards, we must first investigate and reconcile the differences of opinion which exist within our own industry. Having accomplished this, we must find where our practices differ from those in other industries and come to an agreement."

The committee went to work, put their own house in order, and accomplished this gigantic task when it published the first edition of the SAE Automotive Drafting Manual in 1950. At a subsequent SAE meeting Mr. Siler praised the members for their efforts, but reminded them:

"If national drafting standards are to become a reality, an effort must be made to select and specify the practices best suited to the needs of all industry, regardless of conflict with current practices which may exist in other industries."

He proposed that a joint committee of representatives from the automotive and aircraft industries be formed to reconcile the differences in the drafting practices of those two industries. Special consideration was to be given to geometrical and positional tolerances, since these are the areas in which unity of thought and uniformity of expression are least evident. A joint committee was officially organized in August, 1951 and has been at work ever since. To date, this committee has made considerable progress in bringing the drafting practices of not only the two industries into agreement, but also those of Britain and Canada. The committee's work is not completed, but at a forthcoming meeting it is expected to complete the technical aspects of the first draft which is to be circulated to industry for comment. Under SAE procedures, industry comments will be reviewed by the joint committee as a basis for further revision of the draft. It will then be submitted to the SAE Technical Board for final approval and publication.

Meanwhile in 1948, the American Standards Association appointed a sectional committee under the chairmanship of Professor R. P. Hoelscher of the University of Illinois. This committee is reviewing and revising the 1946 edition of the American Standard for "Drawing and Drafting Room Practice." It is also giving consideration to the British proposals. As in the past, this activity is sponsored by the American Society of Mechanical Engineers and the American Society for Engineering Education. To date, this committee has seven of its seventeen sections of the standard approved and expects to have the remainder of its work circulated to industry for comment in the near future.

It can be seen from the above that several national societies representing a cross section of American industry are actively engaged and concerned about national drafting standards. Not one of the proposals which have been circulated by these authorized agencies of industry recommended further simplification of drafting practices.

In the December, 1953 issue of *Dun's Review*, Mr. W. L. Batt, formerly a United States member of the Defense Production Board of the North Atlantic Treaty Organization, had this to say, "We need, first of all, a comprehensive set of true national standards within the United States. Our industry is the most highly standardized in the world. Application of the principles of standardization is perhaps the most outstanding characteristic of American management. But we still do not have such national standards. We sorely need the economies, the increased production, and the added efficiency that they would be bound to bring."

For the first time in history, we find practically all of American industry participating in this most difficult task of reviewing existing drafting standards. The need for national standards is evident, for the bitter and costly experiences of World War II are still fresh in our minds. Exchange of military and civilian goods between NATO countries and those who are friendly to our democracy will continue for years to come. The graphic form of communication must become what it should be—a truly universal method of conveying information by means of drawings.

The outstanding work and accomplishment thus far has been no minor achievement—national and international standards are in sight! Let's face the issue—Should drafting standards be further simplified? If so, how? By omission of detail or by establishing uniform and adequate practices that cannot be misconstrued?

The reader has the facts—let him decide.

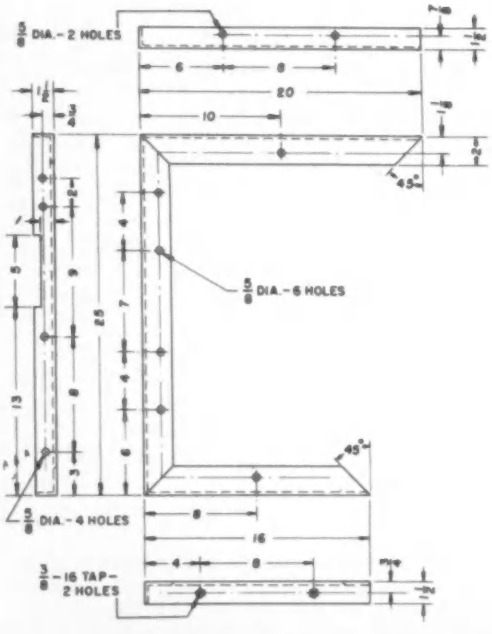
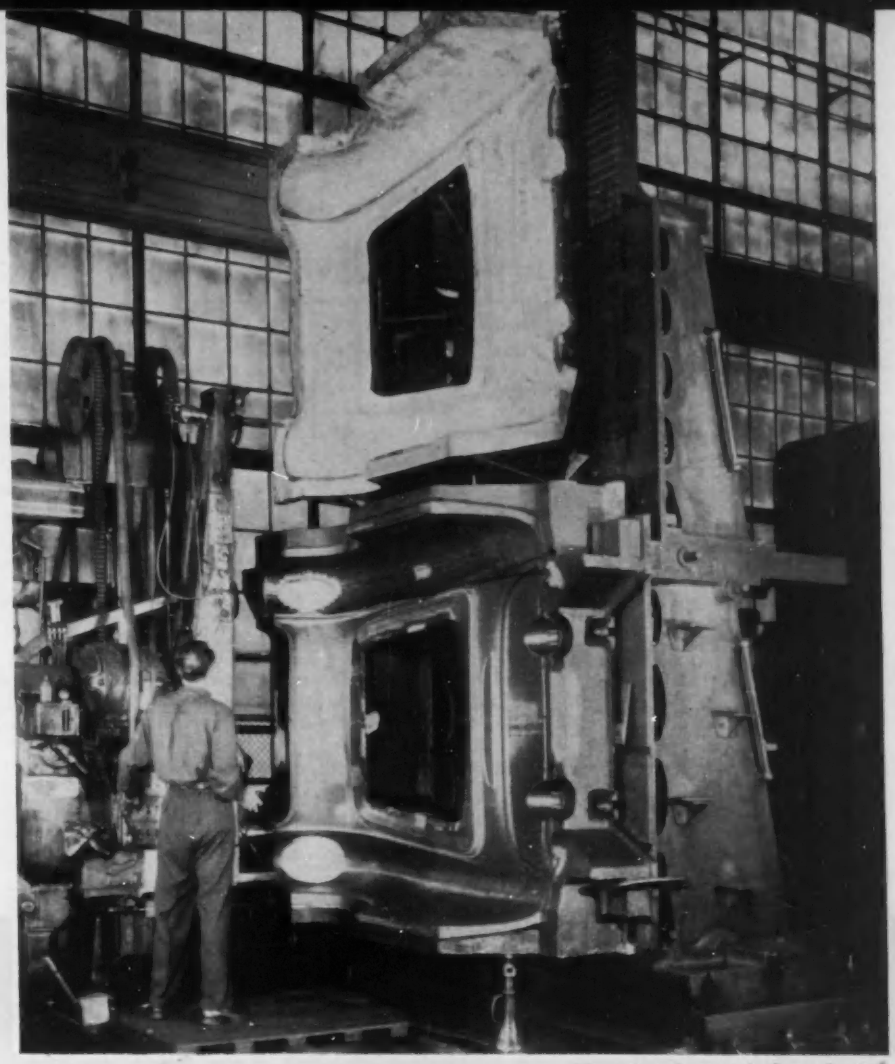


Fig. 5—Conventional drawing of simplified one shown on the preceding page. Everything is "pictured," proportions are visualized and dimensions shown "as is."



Chevrolet's Corvette body production.

Advances in . . .

Reinforced Plastics

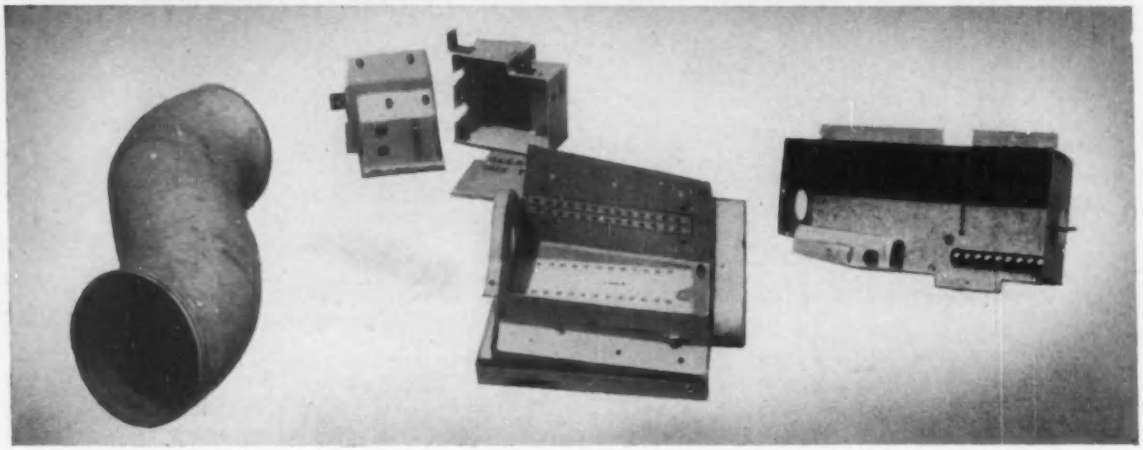
GEORGE LUBIN and MAURICE MARTIN
Bassons Industries Corporation

REINFORCED PLASTICS have developed in one decade from the trial-and-error stage to a point where they are now considered as promising engineering materials. Their development is no longer concerned primarily with how they can be produced, an important factor in previous years, but what properties do they exhibit after they are produced, and are these properties reliable. Reproducibility of properties has become of even greater importance with the introduction of newer resins and newer reinforcements. There are now at least six types of resins and an even greater number of reinforcements used in commercial reinforced plastics making possible a large number of combinations formulated for specific design needs. Still further modifications are introduced by processing them at various pressures, temperatures and curing cycles. For some time, the Society of the Plastics Industry has been engaged in a project to establish standards for reinforced plastics comparable to the NEMA specifications for high pressure

Table I—Property Guide to Material Selection

Property	Resin	Reinforcement	Aver. Range of Values
Flexural Strength, psi	polyester, epoxy, phenolic	glass fabric	40,000–80,000
Tensile Strength, psi	polyester, epoxy, phenolic	glass fabric	25,000–40,000
Compressive Strength, psi	polyester, epoxy, phenolic	glass fabric, mat or rovings	25,000–38,000
Impact Strength, ft lb/in.	polyester, phenolic	glass fabric, cotton fabric	12–16
Water Absorption, % 24 hr.	polyester, DAP, epoxy	glass fabric, mat or rovings	0.5–.2
Modulus of Elasticity, x10^6 psi	polyester, phenolic	glass fabric, asbestos fiber	2.5–4.0
Heat Resistance, F.	phenolic, TAC, silicone	glass fabric, mat or rovings	350–600
Dielectric Strength, v/mil	polyester, DAP, epoxy	glass fabric, paper	300–500
Arc resistance, sec.	DAP, silicones	glass fabric, asbestos fiber	120–200

AIRCRAFT PARTS are among the leading applications of reinforced plastics because of ultra high strength-weight ratio afforded by these materials. Reinforced plastic parts here include heating duct, junction box assembly, bus tie-in relay box and cover assembly, and a circuit breaker shield assembly in various contours.



laminates. So many are the variables to be considered, however, that it will probably be several years before a substantial number will be ready. Meanwhile in the application of these materials, it is of value to the designer to acquaint himself with the newer developments in these materials, the range of properties afforded by various combinations of resins and reinforcements, and the variables which affect not only these properties, but also in turn, the selection of a particular type of reinforced plastic for specific use.

Resin and Reinforcement

The six common types of resins now used in reinforced plastics include: The polyester resins, triallycyanurate-polyester (TAC) resins, allyl resins, of which diallyl phthalate is the newest, epoxy resins, phenolic resins, and silicones. Many reinforcement materials are coming into use for special purposes. Nylon has been applied for highly waterproof combinations, and sisal, one of the first reinforcing materials used, is now being applied as a low cost reinforcement when no critical mechanical values must be met. Among the newer materials being considered as reinforcements are polyester and acrylic based fibers and other synthetics. Of course, as is commonly known, glass fiber in the form of cloth and mats, is still the most frequently used reinforcement.

In selecting reinforced plastics on the basis of properties, where flexural tensile, or shear strength are of paramount importance, Table I, the design engineer will select a glass fabric reinforcement in combination with one of three resins. If strength were the only critical factor, polyester resin would be selected because it has good general purpose properties and is lowest in cost. But if better heat resistance were desired also, as in hot air ducts, the resin selected might be phenolic; and where high moisture resistance might be a basic require-

Table II—Physical Properties—TAC Glass Cloth and Mat Laminates*

Service Temp., F.	Post-cure		Flexural Strength, psi		Flexural Modulus, x10⁶ psi
	Time, hrs.	Temp., F.	Cloth	Mat	Cloth
			31,500	21,000	2.4
75	3	500	46,800		
75	½	500	25,700		2.4
500	3	500	27,200	14,700	2.15
	24	500	32,800	13,000	2.48

* Data courtesy of American Cyanamid Co. Sample Tested was ⅛-in. laminate made with 11 plys of 181-114 glass cloth with 41 percent resin content. Cured for ½ hr at 220 F. 50 psi.

Table III

Physical Properties—DAP Glass Fabric Laminates*

Property	Value
Flexural Strength, psi	
ult.	62,350
yield	51,267
Tang. prop. limit	33,625
mod.	2.8 x 10⁶
Tensile Strength, psi	
ult.	40,800
yield	30,400
mod.	2.5 x 10⁶
Compressive Strength, psi	
ult.	30,200
yield	20,200
mod.	3.8 x 10⁶
Izod Impact, ft. lb./in.	15.0
Water abs., %, 24 hr.	0.22 max
Thickness Increase, %, 24 hr.	0.00 max
Hardness, Rockwell M	118
Flexural Strength at 160 F	
Flex., ult., psi	53,600
mod.	2.6 x 10⁶

Data courtesy Shell Chemical Corporation. Laminates were 181–114 glass cloth, 38.3 percent resin content, made according to USAF Spec. No. 12049.

Table IV—Variations in Mechanical Strength in Laminated Glass Fabric

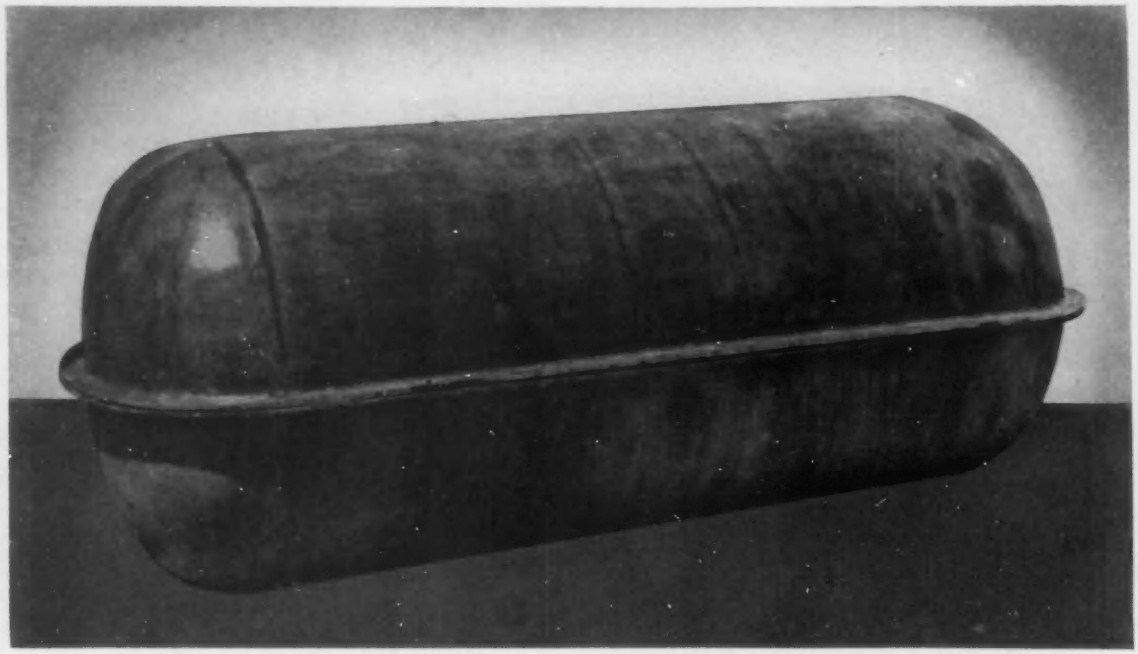
Sample	Compressive Strength, psi			Flexural Strength, psi		
	High	Low	Average	High	Low	Average
1.	32,000	26,800	29,300	45,300	43,000	44,600
2.	33,300	27,900	30,000	45,700	43,800	45,000
3.	37,400	33,300	35,000	46,700	44,300	45,300
4.	33,000	22,500	26,700	40,200	37,400	39,300

ment, epoxy resin would be more suitable.

If the major specification is high temperature resistance, silicones, which are the most difficult to mold and the most expensive, may be selected. However, if the service temperature will not exceed 300 F, the less costly phenolic will be used. The fairly new resin, TAC polyester, retains both strength and good electrical properties over a wide temperature range, and could be called on for use under such operating conditions, Table II. Concerning the reinforcement, glass fabric, glass mat, or asbestos fiber would be equally satisfactory in performance. Asbestos would be cheaper, but it is not always as available as glass, nor as controlled in uniformity.

Frequently, where high dielectric strength is the basic requirement as in terminal boxes, paper reinforcement is chosen. But if the part is to function also at high temperatures, the more expensive glass fabric is used as the reinforcement. Of the three possible resins in compounds designed for high dielectric strength, the polyesters will be used for ordinary conditions. The higher price diallyl phthalate, Table III, provides somewhat higher dielectric strength, while epoxy resins, the most costly of the three, may be used if high values are also required for mechanical strength and moisture resistance. Again, where high dimensional stability during molding is important, as in the production of jigs, the epoxy resins are unsurpassed.

Reference to Table I can be of assistance to a design engineer with a specific problem as a preliminary guide to reinforced plastic material selection. If, for example, the problem surrounds a primary aircraft structure, the principle requirements are high mechanical strength in certain directions, and good moisture resistance. The most suitable reinforcement is therefore a uni-directional glass fabric laid up so that, after impregnation and curing, maximum strength lies along the plane of maximum stress. The choice among the three possible resins, polyester, diallyl phthalate, or epoxy, would be made on the basis of the same considerations as in dielectric strength. Thickness of the structure would be determined by the flexural



JET ENGINE CONTAINERS represent a recent development in the use of reinforced plastics. This container must resist an impact producing an acceleration of 20 g's as measured at the impact face of the container.

and tensile strength to be specified.

Ducts for aircraft would require a different balance of properties: light weight, good heat resistance, nonporosity, and frequently structural stiffness. A fine-weave glass fabric and phenolic resin combination would serve the requirements. If heat resistance were not necessary, a polyester would be satisfactory in performance and at a lower cost. Ducts are produced usually by hand layup around a destructible plaster mandrel. Cellophane is wrapped around the entire layup, and, when heat is applied to cure the resin, the cellophane shrinks enough to supply a certain amount of pressure. This makes it possible to introduce undercuts and odd shapes.

As mentioned previously, there are in practice many variables which modify the values of even the same basic formulations. The method of processing, the pressure and temperature used, the resin-reinforcement ratio, the reinforcement finish, and other factors affect the result. For example, postcure of phenolic, silicone, or TAC formulations for 72 hr may increase the value of certain properties such as flexural strength as much as 300 percent.

A striking example of variation in property values is evident from laboratary data obtained in tests conducted on various standard-weave glass cloths, supplied by several sources, but impregnated in the same resin batch by standard techniques. Yet even under these controlled methods the property values were far from uniform. In compressive strength, Table IV, there were disparities of more than 28 percent between the highest and lowest average values. Differences in tensile strengths were as high as 15 percent.

Methods of Fabrication

A major variable in the property values of reinforced plastics can be attributed to the method of fabrication of which there are three:

1. Hand Layup. The reinforcement is laid over the mold and brushed with resin until it is thoroughly impregnated. Successive layers are built up to the required thickness; sheets of pre-impregnated material may also be used. With the addition of a suitable catalyst, some resins will cure at room temperature with no additional pressure. This method is used generally for the fabrication of large, complex shapes. Since labor costs are high, only limited production is feasible. Low cost tooling, however, affords the opportunity to make short production runs of specialized products without the excessive expense of precision matched metal molds.

2. Vacuum Molding. There are two variations of this method. In one, the first stage is a hand lay-up. Then the charged mold is enclosed in a rubber or plastic bag and the air is evacuated, so that the charge is squeezed tightly and uniformly into the mold. After hardening sufficiently to take the shape of the mold, the part is removed and cured under heat supplied by infrared lamps, autoclave or oven. The mold is usually made of wood or plaster. Its low cost makes it possible to produce a sample part at reasonable cost, and with proper handling the same mold can be used over again for the production run.

A second type of vacuum molding, known as the vacuum injection method, requires a male and female mold. Hand layup, on the male for example, is dry—without resin. Then the female mold is set into place and the resin is poured into a trough built around

the lower edge of the male mold. A vacuum is drawn through the uppermost point in the female mold, pulling resin up into the mold, thoroughly filling the cavity and impregnating the reinforcement previously placed inside. The chief advantage claimed for this method is that it eliminates possible air bubbles from the resin, thereby yielding a denser, stronger, non-porous part. The technique is recommended for large parts, such as structural members, which require male and female molds. The need for two reasonably well-matched molds naturally increases the cost over that of wet layup methods.

3. Matched Metal Molds. This method requires precision molds operating under pressures of from 50 to 1,000 psi, and in a temperature range from 180 to 350 F. The molding cycle is therefore speeded up, varying from 20 sec to several minutes. Matched molds make possible the production of precision parts with good surface appearance. For exceptionally long runs, chrome-plated steel molds may be required, but aluminum molds are serviceable for most purposes.

Design Consideration

The lack of standardization involving reinforced plastics is reflected in the lack of design engineering knowledge based on the use of these materials. In general, sharp corners cannot be achieved in any of the reinforced plastics. If it is attempted with a fabric, for example, the reinforcement is compressed on the inside edge and stretches on the outside edge. Excess resin is squeezed out to the outside surface. This area will be "resin-rich" and, since it is without reinforcement, may chip and thereby weaken the surface area along the corner.

Since the quality of reinforced plastic parts is still based largely on individual experimentation, the design engineer can best obtain the maximum requirements by developing performance specifications most satisfactory to himself and a molder. A great many parts are being made now under government contracts either directly for the Armed Forces or for prime contractors. Their performance specifications therefor offer a useful guide, as exemplified by these specifications for rigid and flexible heating and ventilating ducts:

"Water Resistance". Samples of finished ducts 12 in. long shall be completely submerged in tap water for a period of three days, then removed and allowed to dry for one day. Immersion in water and drying shall be conducted at 70±5 F. After drying, samples shall be tested for resistance to pressure and maximum temperature.

"Pressure and High Temperature Testing". Air at the required temperature shall be passed through the specimen at a velocity of 80 to 100 ft per sec for a period of 70 hr at an ambient temperature of 70±5 F. The pressure shall be the maximum as specified for the type being tested. The specimen shall be mounted so that the heated air will pass through a minimum of 12 in. of tubing equivalent in diameter to the specimen, before entering the test specimen and after leaving the test specimen to be exhausted. The temperature of the air shall be taken at the point entering the test specimen and the temperature control shall be within 5 percent of the required temperature. At the end of the 70 hr period and with the specimen maintained at temperature, the sample shall be subjected to the required air pressure and vibrated at ambient temperature of 70±5 F for one hour. Any delamination, cracking or permanent distortion which would affect the serviceability of the ducts shall be cause for rejection.

Vibration. The duct shall be subjected to a vibration test at a frequency of 55 cps and a double amplitude (total excursion) of 0.060 in. per linear foot of duct being tested for a period of 150 hours. One end of the duct shall be fixed to a stationary (non-vibrating) fixture and the other end vibrated as specified above.

Flame Resistance. Sections of finished ducts 8 in. or more in length should be used. The test specimen shall be supported with its axis at an angle of 45 deg. The burner should rest upon a horizontal surface. The burner shall be adjusted for no air intake, giving a yellow-tipped 1½ in. high flame. . . . The period of application shall be 30 sec with one-third of the flame in contact with the material. Upon removal of the flame source from the specimen, the flame shall extinguish itself within 15 sec and no smoldering or glowing shall be visible 10 sec thereafter. No complete penetration of the material shall result.

Reinforced plastics, therefore, are progressing along the familiar pattern whereby greater use is dependent on a more thorough knowledge of the engineering properties of a material.

Delicate test equipment is protected against impact by reinforced plastic cases.

Movable and Fixed Core Motion Transducers

ALBERT E. NEWTON
United Shoe Machinery Corporation

Developed for connecting directly into standard recording oscillographs, these two pick-ups have proved to be versatile yet inexpensive design tools. Uses that are discussed include a tooth-by-tooth study of gear rotation and an analysis of the loads and stresses in a camshaft.

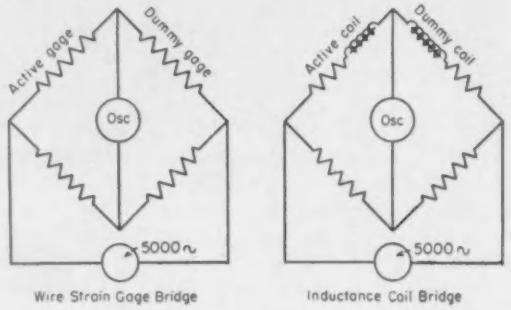


Fig. 1—Both types of motion transducers are used in conjunction with a strain gage bridge circuit. The two types of circuits used most often, the resistance and inductance types, are shown above in schematic form.

IN THE DYNAMIC TESTING of many types of machines, conventional displacement transducers such as the strain gage type are either unsatisfactory or unwarranted. Their range may be too limited, cost too high, accuracy more than required, or they simply may not be adaptable to the job.

Many problems of this type have been solved with pickups that can be made quickly and inexpensively of readily available materials. There are two types of these units. The first is a variable reluctance-movable core pickup; the second is a variable reluctance-fixed core transducer. They were developed to meet the following requirements: (a) simplicity in construction and use; (b) versatility; (c) accuracy sufficient for the particular job; (d) low cost.

Both types of gages may be slightly non-linear. However, in many applications these non-linearities are not important since only the relative timing points of the motions are needed. If, on the other hand, extreme accuracy is required, it is only necessary to carefully calibrate the gages over the ranges that are to be used. Tests made on the movable core transducers have shown that the effect of core velocity is negligible within the range normally encountered in machinery.

These transducers operate in conjunction with a conventional Wheatstone Bridge circuit, powered by an alternating current source. A simplified sketch is shown in Fig. 1. As in a normal strain gage bridge circuit, the active transducer is balanced by an identical dummy transducer. Usually a 120 ohm resistor is placed in series with the two coils to facilitate balancing.

In the movable core pickup, the coil is normally mounted on the frame of the machine and the iron core is attached to the moving part. Any movement of the core relative to the coil alters the amount of iron in the coil and upsets the balance of the bridge. This gives a signal which can be fed through suitable amplifiers to an oscilloscope or oscillograph where it can be recorded and studied.

In the fixed core transducer, the point of the iron core is placed within $\frac{1}{8}$ in. of the moving iron machine element, the action of which is being recorded. Any change in this gap unbalances the bridge and produces a signal.

Fig. 4—Schematic of a typical fixed core transducer being used as a precision tachometer to make a detailed analysis of gear tooth motion.

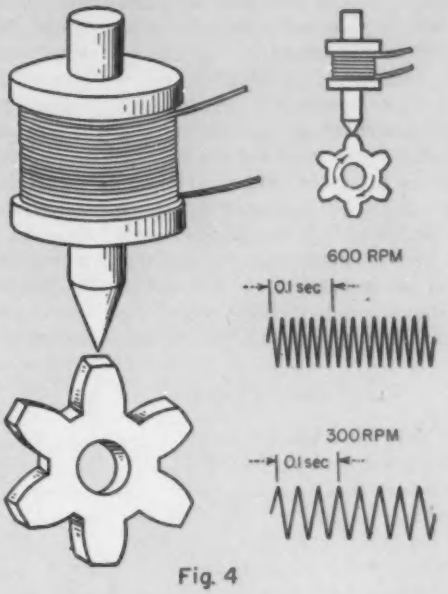


Fig. 4

Fig. 3—Movable core pickup used to study small angular displacements of a mechanism.

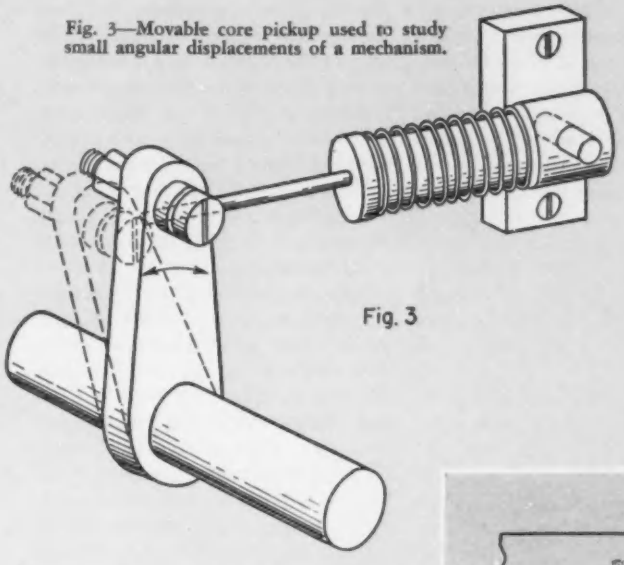


Fig. 3

Fig. 2—Typical construction and basic operation of moveable core transducer. As core moves with respect to coil, output voltage varies as shown at the right.

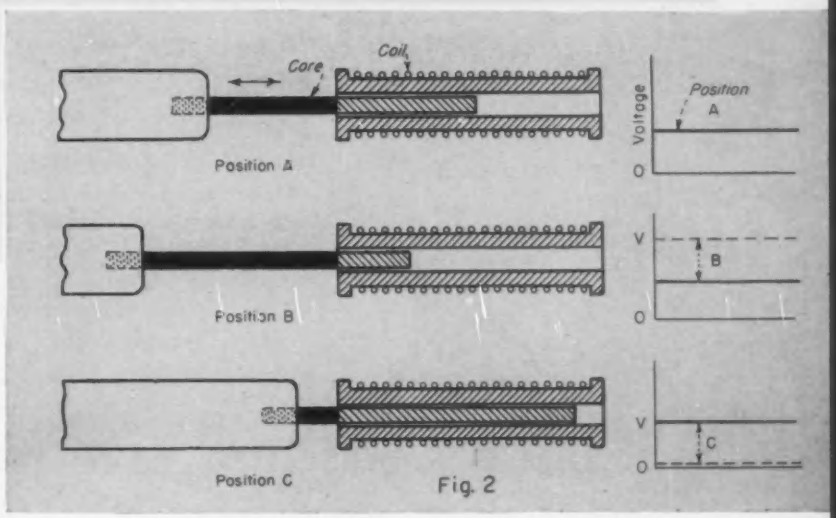


Fig. 2

Movable Core Transducers

The variety of pickups that can and has been used is so great that only a few generalized points will be given. The unit consists of a coil form made of some nonferrous material, usually a plastic. Normally, No. 30 Formex type copper wire is wound on the OD of the coil form as shown in Fig. 2. A small iron rod is attached to the moving part. The free end of this rod or core is placed in the coil in such a way that during the full stroke of the machine the core always moves well within the coil. If the end of the core approaches either end of the coil, the end effects will introduce large errors. The diameter of the iron core should be as small as feasible and should be a loose running fit in the coil hole. Some applications have required as small as $\frac{1}{32}$ in. dia iron cores. At the other extreme, one inch moving shafts and large push rods of the machine itself have been used as the cores. Usually, a $\frac{1}{4}$ in. rod is used with a coil having a $\frac{9}{64}$ in. hole and an OD of approximately $\frac{1}{2}$ inch. The length of the coil will vary with the stroke to be measured.

Tests have shown that no appreciable error is introduced by virtue of the core not remaining in the center of the coil during a test.

The following point also should be stressed: Care should be taken to eliminate residual magnetism in the iron core. Usually a core that is made of a low carbon machine steel will not retain sufficient magnetism to cause difficulty. However, in some applications where high velocities are encountered even small amounts of residual magnetism may introduce errors. In

those cases a brass rod or a stainless steel rod will eliminate the magnetic effects. The signal from a gage using either of these rods will be much lower than for iron rods. By using higher amplifications, a satisfactory record can easily be obtained.

As previously stated, the movable core transducers are primarily linear motion indicators. Some will indicate motions of $\frac{1}{16}$ in. and less. Others have measured motions up to 20 inches. By curving the coil and core to the proper radius, small angular motions can be recorded. However, Fig. 3 shows a more versatile method for recording angular displacements.

Fixed Core Pickup

This device consists of an insulating coil form surrounding and attached to a soft iron core. Several layers of insulated fine wire are wound on the coil. As shown in Fig. 4, the tip of the iron core is shaped in various ways to fit the application. Some of the small pickups have used $\frac{1}{32}$ in. wire as the fixed core. For most applications, a $\frac{1}{4}$ in. low carbon machine steel rod is used.

The principal use of the fixed core transducer has been as a precise tachometer. Not only will it give the usual speed measurements, but it will also record any changes in speed during a fractional part of a revolution. A number of machines have had troubles that could be traced to nonuniform rotation during a single cycle. Referring to Fig. 4, it can be seen that on the curve that recorded the passage of the tips of the teeth the peaks were spaced further apart when the gear was revolving slower. When the gear was revolving faster, the peaks were closer together. The chart paper speed which gave the time axis was the same in both tests.

Usually it is advantageous to remove or change one tooth so that a reference point is established for each revolution. This greatly facilitates interpretation of the records. The reference point can be chosen so that it occurs at either the beginning or at some other important part of the cycle.

If the direction, as well as the speed of rotation is desired, it is only necessary to alter the gear teeth so that they are unsymmetrical. The oscillograph record of the teeth will also be unsymmetrical and will clearly indicate the rotational direction.

These pickups have been used to record motions as small as a few thousandths of an inch with high sensitivity. However, as motion indicators they are somewhat limited since their normal usable range is only approximately $\frac{1}{8}$ inch. Beyond this range they become quite nonlinear and large errors are introduced.

In one test, it was necessary to count tacks that were sliding down a raceway. One of these pickups was installed in the nonmagnetic raceway cap. As the iron tacks slid down the raceway underneath the tip of the transducer, a signal was generated which could be recorded and then studied.

Typical Application

In the service history of several hundred Welt Butting and Tacking machines, similar to the one shown in Fig. 5, severe breakdown had been experienced. A test was made to determine the cause of these breakdowns as well as possible corrective measures.

The first step in these tests was to obtain simultaneous records of (1) the working loads on the critical main cam, (2) motions of the pounding and tacking heads, (3) motions of the tack drivers, and (4) the rotation of the main camshaft.

The working loads were obtained by cementing a SR-4 strain gage to the cam lever and statically calibrating it in terms of cam roll load. The motions of the pounding heads and the tack drivers were obtained by means of two sizes of variable reluctance-movable core transducers. Finally the rotation of the main camshaft was obtained by installing a fixed core variable reluctance gage adjacent to a 68-tooth steel gear that was a part of the driving mechanism. This gear was mounted on the main camshaft.

All of these signals were fed into a recording oscillograph. A typical cycle is shown in Fig. 6(a). Three

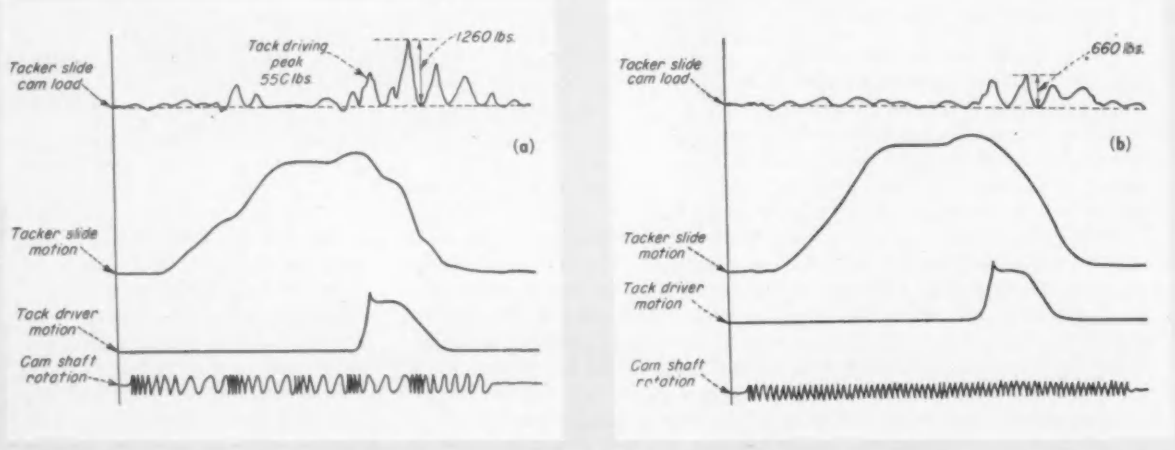


Fig. 6—(a) Oscillogram of Welt Butting and Tacking Machine with single key clutch. (b) Same machine with double key clutch.

important things were immediately noted in this record: (1) The peak cam load was approximately 1260 lb; (2) this peak occurred at the instant the tack drivers were picked up during the rapid return of the pounding heads; (3) one of the camshaft high-speed points occurred at the instant of the peak cam load.

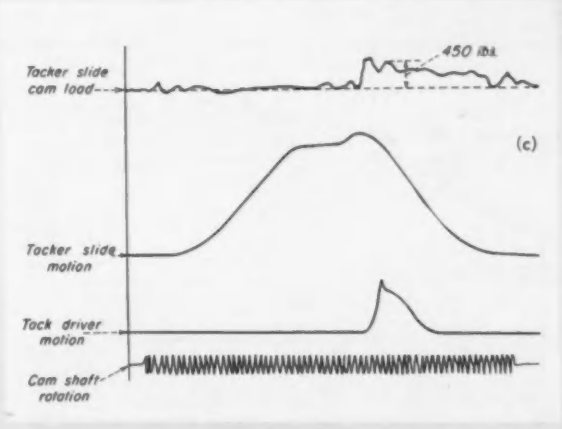
Upon studying the records, it became clear that part of the peak cam load was due to this speed up and the associated inertia effects. To determine how much trouble was resulting from this erratic rotation, it was decided that its cause should be corrected. After making some further tests the trouble was found to be in the action of the single key clutch that drove the main camshaft. A sketch of this clutch is shown in Fig. 6(d). It was found that as the key rolled in, the driving ring hit it. Whereupon the camshaft raced ahead and the key left the driving ring face. A moment later the camshaft slowed down and the driving ring caught up with the key and gave the camshaft another kick. As shown in Fig. 6(a), this repeated five times during the cycle.

To eliminate this trouble, a double key clutch was designed, also shown in Fig. 6(d). Once the main key rolled into place a secondary key also rolled into engagement and prevented any racing ahead of one part with respect to the other. With this experimental clutch installed in the machine, the oscillograph records showed that the load was reduced almost by one half as shown in Fig. 6(b). The erratic rotation was completely eliminated.

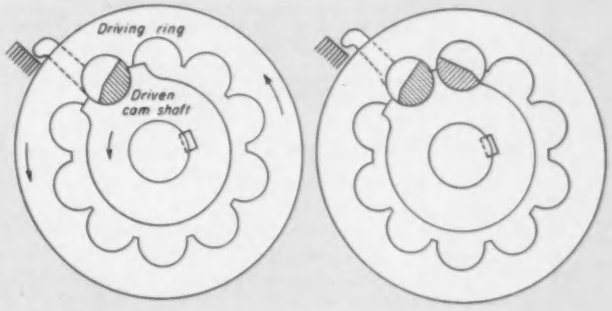
However, the problem wasn't completely solved by this new clutch, since the 660 lb peak load was still too high for the cam. Theoretically, the peak safe load for the cam was approximately 500-550 pounds. Referring to the original oscillogram, it was pointed out that the picking up of the tack drivers also occurred at the peak load instant. Therefore, it was felt that it should be possible to further reduce the load by retiming this picking up point so that it came a few degrees ahead of its normal point. This would fill in the "valley" which was just ahead of the peak load and thereby improve the load pattern.

This retiming was done and the oscillogram (see Fig. 6c) showed that the peak load was reduced to approximately 450 lb. Since this was well below the critical load, it was felt that no further difficulty would be experienced. The proof was found in the fact that machines that had previously been the chief offenders no longer had this breakage trouble after the improvements described above had been made.

Fig. 5—View of a Welt Butting and Tacking Machine with test set up.



(d)



(c) Machine with double key clutch and new timing. (d) Sketches of single and double key clutches.

Fastening Sheet-Metal Parts by

Detachable and permanent assembly of sheet metal

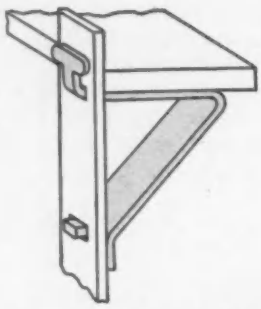


Fig. 1—Supporting bracket formed from sheet metal and having integral tabs. Upper tab is inserted into structure and bent. Lower tab is held in place by weight of ledge.

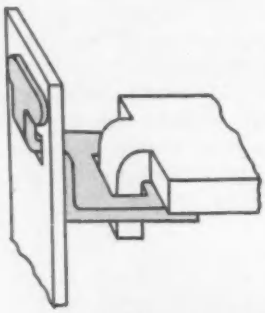


Fig. 2—Supporting bracket similar to Fig. 1 but offering restraint to shelf or ledge. Tabs are integral with sheet metal part and are bent on assembly to form support.

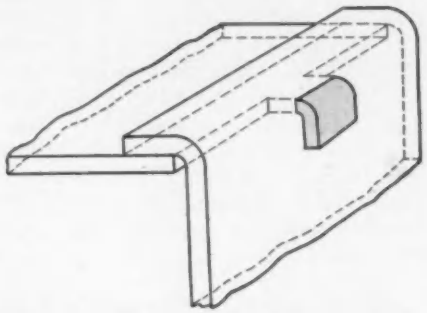


Fig. 3—Supporting ledge or shelf by direct attachment to structure. Tab is integral and bent on assembly. Additional support is possible if sheet is placed on flange and tabbed.

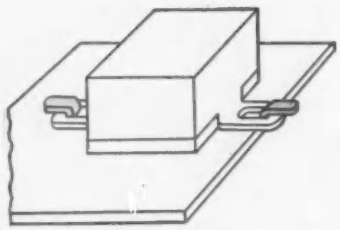


Fig. 7—Box section joined to a flat sheet or plate. Elongated holes are integral with box section and tabs are integral with plate. Design is not limited to edge location.

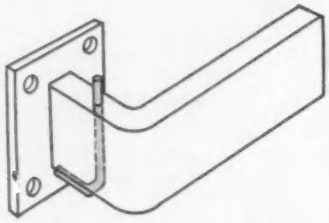


Fig. 8—Bar is joined to sheet metal bracket by a pin or rod. Right angle bends in pin restrict sidewise or rocking motion of bar. Bracket end of pin is peened.

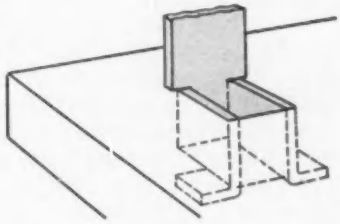


Fig. 9—To support and join sheet metal support at right angle to plate. Motion is restricted in all directions. Bottom surface can be grooved for tabs allowing for a flat surface.

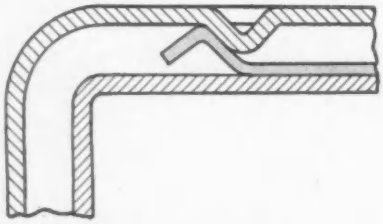


Fig. 13—A spacing method that can be used for circular sections. Formed sheet metal member support outer structure at set distance. Bead centers structure and restricts motion.

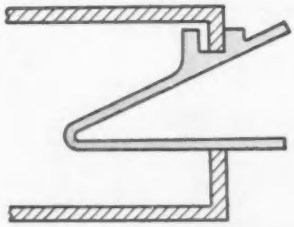


Fig. 14—A removable section held in place by elasticity of material. Design shown is a temporary or a removable cover for an elongated slotted hole in a sheet metal part.

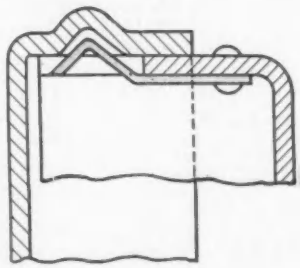


Fig. 15—A cover held in position by bead and formed sheet. Cover is restrained from motion but can be rotated. Used for covers that must be removable for some reason.

Tongues, Snaps or Clinching

parts without using rivets, bolts or screws

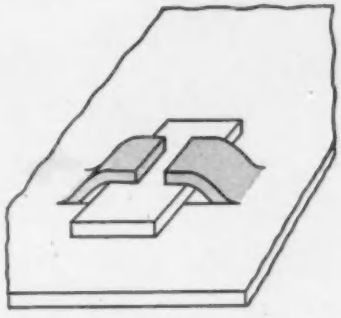


Fig. 4—To support or join a flat sheet metal form on a large plate. Tabs are integral with plate and bent over on assembly. Only sidewise motion is restricted with this method.

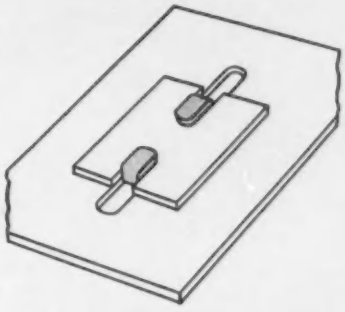


Fig. 5—Similar to Fig. 4 but motion is restricted in all directions. Upper sheet is slotted, and tabs are bent over and into slots on assembly. Tabs are integral with bottom plate.

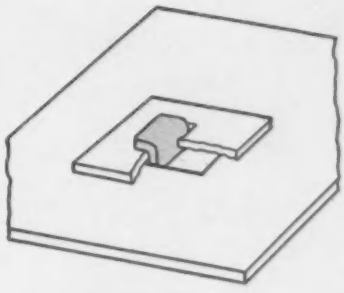


Fig. 6—Single tab design for complete restriction of motion. Upper plate has an elongated hole that matches width and thickness of integral lower plate tab.

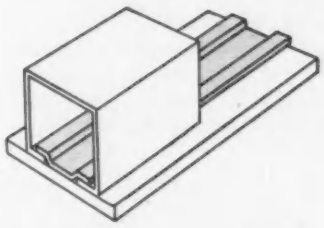


Fig. 10—Channel section spot welded to plate forms bottom surface and joins box section to plate. Channel edges can be crimped or spot welded to restrict motion.

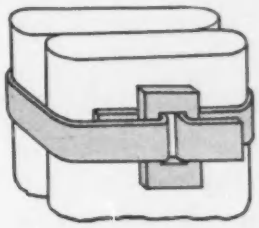


Fig. 11—Sheet metal strap used to join two flat surfaces. Edges of plate are rounded to allow strap to follow contour and prevent cutting of plate by the metal strap.

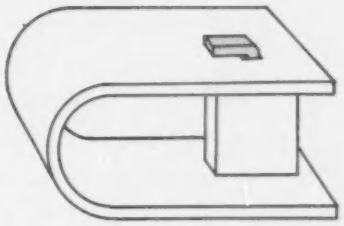


Fig. 12—Sheet metal structures can be spaced and joined by use of a tabbed block. Formed sheet metal U section is held to form by the block as shown.

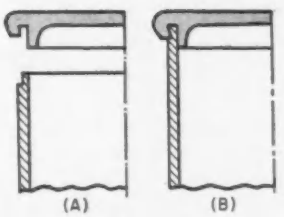


Fig. 16—A non-removable cover design. The vessel is notched as shown in *A*, and the cover crimped over, *B*, on assembly. This is a permanent cover assembly.

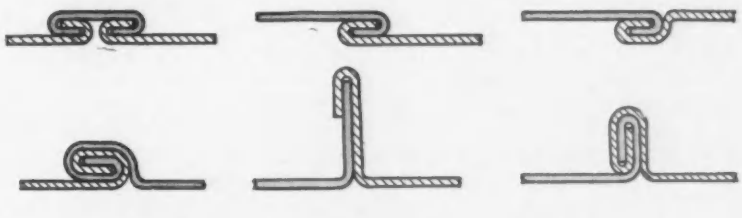


Fig. 17—Six methods of joining two sheet metal parts. These can be temporary or permanent joints. If necessary, joints can be riveted, bolted, screwed or welded for added strength and support. Such joints can also be used to make right angle corner joints on sheet metal boxes, or for attaching top and bottom covers on sheet metal containers.

TWO HERMETICALLY SEALED thermostats with silicone rubber overmold and mounted leads on partial assembly of rocket pod tubes of Lockheed F 94 fighter.

Lockheed Aircraft Corporation

Thermostatic Controls

How stringent performance requirements and operating conditions can be overcome, particularly in aircraft. Recommended specifications that are adaptable to exacting applications.

FRANK APPLETON
Spencer Thermostat Division
Metals & Controls Corporation

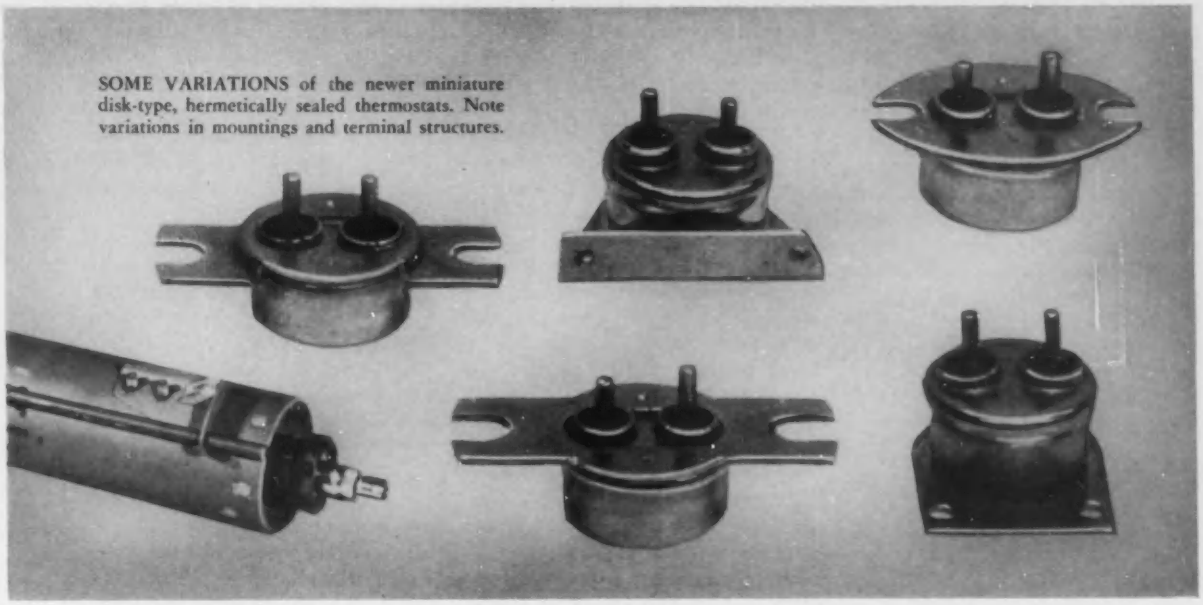
THE MOST EXACTING REQUIREMENTS in the application of thermostats are found in military aircraft. Increased extremes of ambient temperature, ranging from —65 to +160 F, closer physical and operational tolerances, increased wattages, and greater compactness, have all contributed to the increased difficulties in the design and application of thermostatic control systems. Thus, the designer is confronted with the paradox of designing devices that must operate under more and more unfavorable conditions with an ever-improving exactness of performance.

Control of the temperature under which an instrument or device operates may be required for any of a number of reasons. Aerial cameras must have small heaters placed at various points and thermostatically controlled in order to keep lenses free from clouding, prevent the photographic film from getting brittle and to maintain the lubricants at the proper viscosity to assure correct shutter speed and other essential operation. Similarly, airborne electronic equipment and other devices must be carried in heated chambers with controlled temperature.

Some times thermostatic control is required to keep the device cooled to the proper temperature. One such early application was to radio transmitters which were equipped with cooling fans with on-and-off thermostatic controls. Today, there is an increasing demand for thermostats to control cooling fans and blowers because of the extremely high temperatures produced by jet engines. Another factor in this trend is the general boost in wattage of many of the devices along with reduction in physical size. Small heat radiating surfaces and poorer ventilation makes it necessary to cool the instrument.

Whenever a designer starts the development of an aircraft instrument or device, one of the first things he must do is to determine whether or not he will have to provide for warming or cooling of the device. If the device utilizes electric power, possibly it will have to be cooled by a fan. If the equipment is going into a supersonic aircraft such an investigation should always be made because of the high skin temperatures developed in flight.

The failure to make an early analysis to determine whether or not temperature control will be required may be costly and time consuming. In more than half the applications about which the writer has been consulted, no previous consideration had been given to thermostatic controls. Design work had been carried so far that only with difficulty and considerable added



SOME VARIATIONS of the newer miniature disk-type, hermetically sealed thermostats. Note variations in mountings and terminal structures.

cost had it been possible to include thermostats without making drastic dimensional changes in the device. In some instances almost a complete physical redesign was required.

If the device is to have thermal control, the first step will be to determine the exact location of the device in the airplane. This will enable the designer to obtain accurate thermal data, taking into account the heating effects of nearby devices. Having determined the temperatures surrounding the instrument, the next step is to determine the temperatures developed by heat generated within the instruments. Usually this figure is the power loss in an electrically operated instrument or device.

In discussing the temperature to which an instrument is subjected, one must be careful in the use of the term "ambient temperature." It means the surrounding temperature and implies that at no point is the temperature much different from the mean. Often the temperature to which an instrument is subjected will not be primarily the "ambient temperature" of the compartment in which it is but rather the result of temperatures developed by radiant heat from surrounding devices. These radiant heat temperatures may be as much as 50 to 100 F higher than the compartment temperature only a few feet away. In addition to the temperatures developed from heat sources outside the instrument, the designer must also estimate the temperatures created within the instrument by energy losses in its operation.

The amount of heating or cooling required to keep the instrument at the proper temperature can be determined exactly only by test. If it is impossible to determine experimentally the rate at which heat must be supplied or taken away, the designer will have to rely on calculations plus judgment. In that event he should allow sufficient space so that a larger resistance heater or cooling fan could be installed if necessary.

After the amount of heat to be supplied or dissipated has been established, the power consumption of the heating element or cooling fan can be calculated. This quantity frequently is greater than the wattage requirements of the instrument itself. Often this additional demand may require additional power supply capacity. If this is not anticipated early enough so that provisions can be made for it, a great deal of trouble might result. In one instance, a desirable piece of equipment ultimately had to be discarded because its power requirements had not been anticipated early enough in the original design.

Having determined the wattage of the heating element or the power required to drive the cooling fan, the next step is choosing the thermostat.

There is no "general purpose" thermostat that can be applied successfully to every application in military aircraft. Long experience has established the fact that factory pre-set non-adjustable thermostats designed and engineered for the specific type of application give the most dependable service. Efforts to utilize adjustable temperature features have led to confusion and frequent field failure, mainly for two reasons. Adjustable temperature thermostats are extremely difficult to calibrate correctly by the customer. Furthermore, there is always the possibility of someone tampering with the adjustment, an ever-present danger.

A trend toward factory pre-set and factory installed temperature controls in our domestic heating and ventilating equipment is the result of just such unfortunate experiences with adjustable controls.

There are three essential requirements which must be met by all thermostats for airborne applications.

1. They must operate with snap action.

2. They must not be affected by altitude nor environment.

3. They must not be adversely affected by any temperature to which they will be subjected.

Because of vibration, shock and acceleration to which airborne instruments are subjected, all aircraft thermostats require snap action charac-

teristics. In addition, freedom from electronic interference is best accomplished with electrical contacts which make and break with a high speed snap. Newest jet engine designs present drastic vibration frequency questions which appear to be answered satisfactorily by snap action low mass thermostat designs. The snap action must be sufficiently positive to maintain the thermal element in the desired position, either "open" or "closed", against all influences except temperature change. Certainly every snap action design will not meet this requirement, but only a snap-action design can meet it.

While it is possible to obtain snap action by mechanisms involving toggles, over-center springs, magnets and other elements, the simplest thermostat design is found in the bimetal disk which obtains its snap action entirely within the thermal element itself. When correctly engineered and properly assembled and applied, it performs over the years without change in its repeatability. Substantial proof of this fact is in the millions of these disk operated controls used annually in domestic and industrial electric motors, as well as the additional millions of disk-type precision circuit breakers installed on military and commercial aircraft the world over. Disk-type room thermostats with temperature differentials of less than two degrees F put in operation twenty or more years ago and having performed hundreds of thousands of times without need of attention are still in service.

In the bimetal disk thermostat, as well as all other snap-action thermostats, there is a predetermined constant temperature difference between the "open" and the "closed" positions. This temperature difference is called thermostat differential. It is designed into the disk and determined when the thermostat is calibrated at the factory. In normal service this predetermined differential does not change although there are certain types of thermostats intended for special service available with adjustable differentials.

A thermostat designed with a specific differential usually will not regulate the temperature of the controlled medium within this same temperature difference because the thermostat element operates in response to its own temperature which may or may not be the temperature of the medium being controlled.

A relatively simple and accurate method to determine the temperature of the bimetal at which snap action takes place is by immersing the thermostat in a constantly stirred liquid bath the temperature of which is changed at a slow rate—no faster than half a degree a minute. Thus, the temperature of the bath at the moment snap action occurs will be substantially the same as the temperature of the disk. In this way the differential may be determined. For temperatures below 32 F the bath is alcohol, above 32 and below 212 F the bath is water, and for higher temperatures oil is used.

Unless a specially designed cabinet with closely regulated controls and extremely high velocity air flow is used attempts to check thermostats in air pretty generally are a failure.

Thermostat differential, force of snap, electrical rating and physical size of thermostat are closely related. The thermostat designer usually aims to produce the smallest possible structure with the narrowest feasible differential and the highest electrical rating although there are times where only one of these may be important. On occasion, for example, wide differential is necessary and other factors secondary.

A smaller differential inherently reduces the electrical capacity, and reducing the size of the disc usually requires widening the differential. Hence, there is need for compromise when the thermostat user sets up his specifications. He must determine which features need be stressed, that is size, electrical rating or temperature differential. He may seriously handicap his application by requiring an unnecessarily small size, thereby losing desired performance; or by specifying unneeded precision, which will lead to high cost. Usually the widest differential allowable should be chosen for best overall performance at the lowest cost, although this too should be a matter for review by the thermostat manufacturer as it is possible to reach a point where differential can be too wide for satisfactory life and economic manufacture.

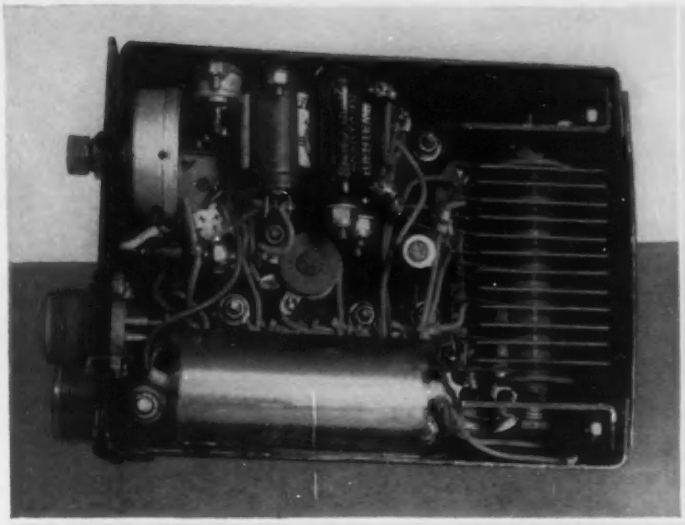
Effects of altitude and surrounding environment, always of concern upon aircraft equipment, are fast becoming a major point for consideration. Continued stepping up of electrical generating capacity with increasing altitude ceilings frequently require qualification for operation at 50,000 feet. In addition, electrical equipment must prove to be free from harmful reactions to sand and dust, humidity and fungus growths. Also, they cannot constitute a fire hazard in the presence of explosive vapors.

To meet these rigid stipulations, hermetically sealed disk-type thermostats have been designed and engineered into a number of modern appli cations, as shown on page 177.

Influence of ambient temperature variations is sometimes overlooked and frequently misunderstood. While it is true that thermostats are employed for the purpose of responding to temperature changes, it is likewise true that normally the thermostat has been designed to control temperatures within relatively narrow limits. The thermostats themselves are instruments and can be adversely affected when exposed to extremely low or extremely high temperatures for which they have not been intended. Therefore, in every instance the maximum and minimum ambient temperatures should be determined, and, as stressed earlier, this must be measured or accurately calculated at the exact point of installation. These data then can be made part of the specifications so that a suitable thermostat will be furnished.

The maximum and minimum ambient temperature limitations of the thermostat are not usually published by the manufacturer, nor is it safe to guess on this point, because the reactions of thermostat metals and many other materials used in the thermostat are known only to the manufacturer. If he is given all the facts, he frequently can make material and design changes which will permit his thermostat to meet the requirements. The writer knows of an example where a standard disk-type thermostat could not be used because of a temperature override condition, but a change was easily engineered by the manufacturer of the thermostat when he became aware of this requirement. It was accomplished by changing the construction which added to the cost and for this reason it is not used in standard production.

In general the minimum ambient temperature to which airborne thermostats will be exposed is minus 65 F. But the maximum temperature is



Northrop Aircraft, Inc.

AS PART OF FLIGHT TEST instrumentation, several types of probe sensing units are used, one of which is this transducer power supply unit. Northrop instrumentation engineers recognized the instability of mercury reference batteries and other batteries at extreme low temperatures when used as a magnetic amplifier-regulated power supply voltage reference. The thermostat is used with a heating element to maintain a constant battery temperature.

HERMETICALLY sealed thermostat with silicone rubber overmold mounted on Joy Manufacturing Company blower where it is used to control duct temperatures on Douglas C 124 Globemaster, manufactured at the Long Beach, Calif., plant of Douglas Aircraft Co.

usually different for each job. Ironically, it is not uncommon for a designer to determine the maximum safe temperature for his equipment and then specify a thermostat calibrated to open several hundred degrees below this figure. In his testing he has found a temperature override or a continuous build-up of temperature after the thermostat opens caused by residual heat. Quite logically he concludes that by fixing the thermostat cut-off point at a value high enough to avoid nuisance opening, but substantially below the safe maximum temperature for his device, he will be assured of holding the temperature within safe limits. Such reasoning is sound enough, but the designer may be overlooking the fact that while the override inherent in the application is safe for his device, it may be too great for the thermostat. For example, a thermostat calibrated to open at 200 F may be assembled in a thermoplastic base which is safely usable only up to 300 F. If this thermostat is applied to a device which has an inherent override of 150 F, it will be clear that the safe maximum of the particular thermostat will be exceeded by 50 F. But if the manufacturer had known the maximum temperature he could offer this same design mounted in a metal base which would be completely suitable for the service.

For testing a complete thermostat application, cold boxes and low pressure chambers should be used to simulate the operating conditions that will be encountered. Thermocouples should be employed for measuring temperatures. Several different designs of thermostats can be checked at the same time. Sample thermostats can also be tested for lag in response to temperature change.

For each thermostat structure there is a maximum rate of temperature change in still air, or on a specific surface, which the thermostat can follow with accuracy. If the rate is faster than this maximum, the thermostat will lag behind and the faster the rate, the greater will be this lag. For airborne applications with their rapid rates of temperature change, it is essential that effects of thermostat lag be considered.

It is not usually feasible for thermostat manufacturers to publish data accurate enough to be generally useful relative to heat absorption and heat loss rates of their thermostats. Too many variables contribute to affect these rates. For example, thermostat metal elements follow temperature rise in still air quite differently from their response in moving air. Also, the velocity of the moving air greatly affects the rate of heat transfer, and plays an important part.

Only testing under anticipated conditions will produce correct results. For such testing a thermocouple may be cemented to the thermal element, and another suspended in the air or attached to the surface where control is required. This direct approach based on actual performance should produce data from which quite accurate preliminary calibration specifications can be worked out.

Thermostat manufacturers can furnish in quantity a limited number of designs for which they have available production tools and calibration and test fixtures. Accordingly, as with any similar manufacturing activity, almost any alteration of structural specifica-

tion presents production difficulties. A change preventing the use of standard tools and fixtures usually will divert the item from a regular assembly line to a special department where it may be side-tracked and delayed. Hence, particularly under present circumstances where production and engineering time is at a premium, good judgment will prompt a design engineer to utilize standard items which he knows can be manufactured from existing tools.

The usefulness of physical samples in preliminary environment testing has been mentioned. For such tests, usually any samples of the exact design and intended for the service will be suitable and generally these are available on short notice.

With completion of preliminary testing comes the need for calibrated operating thermostats. In most instances these must be secured from the factory where they will be built to the designer's specifications. To make certain that correct reference data will be available, usually such test samples are measured in the manufacturer's laboratory and a record kept by him. These samples are costly and much time is consumed in their handling.

Thus, the engineer will want to be certain of his ground before calling for calibrated samples. Much delay usually can be avoided if he will obtain several samples with closely-related settings.

It is obviously unwise to order calibrated samples if final equipment design is uncertain or if changes appear possible.

Normally in aircraft instruments, as in most others using thermostats, it is desirable to put the thermostat next to the heating or cooling medium. For example, with a small chamber requiring heating or cooling, heaters or fans and the thermostat are put in the chamber close by each other.

But not always is it possible or desirable to locate a thermostat inside the equipment. If the designer has failed to provide sufficient space, or if mounting inside is unfeasible because of operational or dimensional limitations, usually an effort is made to clamp the thermostat on the outside. Such attempts generally end in failure because of the inability of thermostats to follow changes in temperature far removed or insulated from them.

However, within recent months another approach has been used with success. An instrument has been added to an airplane as a last minute requirement. Extremely sensitive to temperature variations, it required automatically regulated heat. Under these circumstances the application engineers specified electrically heated blankets to be wrapped around the instrument. There was no possibility of including a thermostat on the device.

Fortunately the solution to automatic control was direct and simple. Instead of mounting a thermal device in the instrument or on the electrically heated blanket, an hermetically-sealed thermostat was spotted in an air scoop remote from the instrument. There it was continuously subjected to outside ambient temperature.

Such a method of control has much to recommend it for aircraft use. Where rapid temperature changes are the rule, any approach is valuable which permits a thermostat to anticipate changes before they register upon the equipment. Here the thermostat directly exposed to outside ambient temperature will anticipate by an appreciable amount of time the effect of these changes on an instrument intentionally shielded from them.

Of two other types of thermostats probably the best known is the thermal circuit breaker. Here a thermostat element is designed and calibrated so as to respond to effects of heat generated by predetermined values of electric current and ambient temperature, the current usually flowing directly through the thermal element. Circuit breakers are designed specifically for the purpose of opening a circuit when current exceeds a safe value. They are intended exclusively to prevent electrical conductors from overheating and creating fire hazards or from destroying themselves. Circuit breakers cannot properly nor safely serve to protect equipment against all conditions of overloading and overheating, although unfortunately they are used for this purpose with frequent unsatisfactory results. The reason will be clear from the following:

In general we may assume that when current flows in a conductor, the conductor will heat in all parts at about the same rate. For the same ambient temperature any device which protects one section will protect any section. How different is this situation with electrical equipment. For in it may be found a variety of sections or parts, each one with its own safe temperature characteristics and heating rate.

Accordingly, the solution to equipment or device protection is found in locating and protecting the section most vulnerable to heat damage because that is the "hot spot" or weak link. But at the same time we must make certain this protector will not limit safe operation of the equipment thus preventing it from performing its required duty. We must provide adequate protection without overprotection.

With equipment items like motors, solenoids and transformers, the hot spot is buried in a winding. Ambient responsive thermostats mounted on the surface of these windings cannot follow rapid temperature rise resulting from heavy current overloads associated with stalled rotor and short circuit conditions. For such protection a current responsive device must be employed. However, we know that a current responsive thermostat mounted remote from equipment will not sense excessive temperatures within the equipment occasioned by such conditions as ventilation failures or high localized ambient temperatures. Thus, it cannot provide adequate protection and permit full available safe performance under all circumstances.

To meet the requirements for comprehensive equipment protection, inherent overheat protectors have been developed. Inherent protectors are mounted as the name indicates, as an integral part of equipment and they are matched to temperature characteristics of the hot spot. They are responsive both to current and temperature, and combine desirable qualities of ambient responsive thermostats and current sensitive devices. They provide protection against any conditions of overloading or overheating from any cause and without limiting safe output.

Thus, it will be seen that three distinct types of thermostatic controls have been designed and engineered for three different uses. Ambient responsive thermostats are intended essentially for use with instruments as automatic heat controls although they also can provide safety cutoff features. Thermal circuit breakers protect electrical conductors and can be expected to do nothing else. Inherent overheat protectors have been contrived specifically for equipment protection.

Nonlinear Techniques In Design

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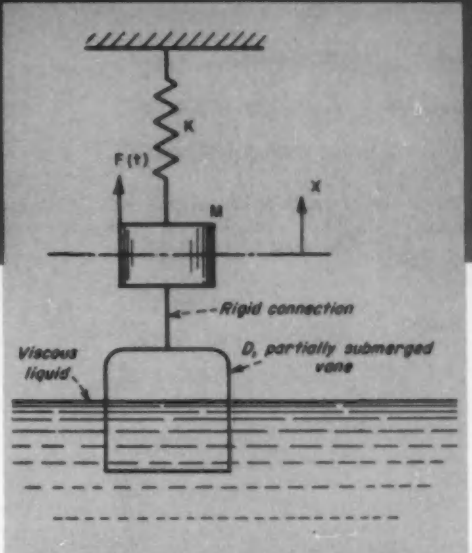


Fig. 1—Basic form of linear system. Linear theory states that the mass is constant, drag is proportional to velocity and spring force is proportional to displacement. There are a large variety of systems that obey the same laws as this basic system.

Nonlinear effects are important because:

• • • Many devices and systems will not operate properly unless nonlinearities are compensated for or eliminated.

• • • Nonlinear effects can be used to extend the operating limits of some systems.

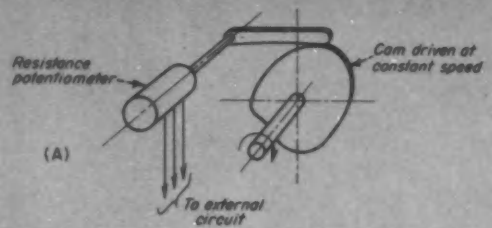
The following material defines and points out typical electrical and mechanical nonlinearities. Also included are two basic approaches to the analysis and solution of nonlinear problems.

NONLINEAR PHENOMENA are those that can be described by nonlinear differential equations. While widely encountered in nature, nonlinear analysis has long been the exclusive province of mathematicians and physicists. However, advancing technology has forced engineers and designers to familiarize themselves with this field, and to simplify its principles, reducing them to the level of practical working tools for the solution of complex problems. Today nonlinear techniques can be applied to the design of open and closed loop control devices and systems, mechanical devices, thermal circuits, and other elements where it is desired to extend performance beyond usual limits.

An examination of nonlinear systems must be preceded by a clear description of the features which characterize such systems, and differentiate them from linear systems. The most precise definition is based upon the linearity or nonlinearity of the differential equation. Where the coefficients of the differential equation are constant, or are functions

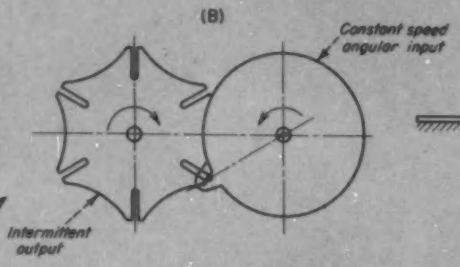
TYPICAL LINEAR SYSTEMS

Fig 2

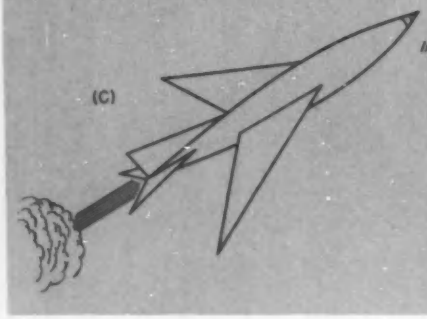


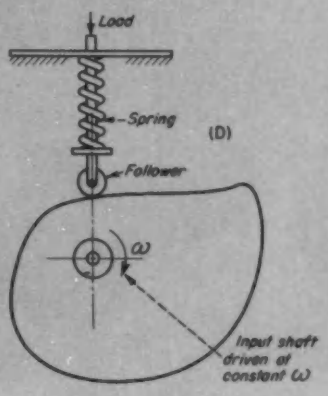
(A) The resistance variation across the potentiometer terminals can be made to vary arbitrarily with time. However, the system is linear since the resistance is not a function of the current which is the dependent variable.

(B) A Geneva mechanism is linear even though motion is intermittent since the intermittent characteristics are in the forcing function and not in the system parameters.



(C) The rocket is losing mass because of the consumption of fuel, but since the loss depends on time and not on the rocket coordinates or their derivatives, the dynamic equations are linear.





(D) Regardless of the nature of the load on the follower, or the contour of the cam, the equations of this system are linear. However, the parameters are not constant but vary periodically with time. The driving force required to maintain a constant ω can be computed.

of the independent variable, the equation is linear; where the coefficients are functions of the dependent variable, the equation is nonlinear. For example, consider the simple system of Fig. 1, containing the fundamental elements of mass, spring, and damping. The differential equation of this system can be written:

$$M\frac{d^2x}{dt^2} + D\frac{dx}{dt} + Kx = F(t) \quad (1)$$

where M = mass
D = damping coefficient
K = spring constant
$F(t)$ = forcing function
x = displacement from equilibrium position (dependent variable)
T = time (independent variable)

Where the coefficients M, D and K are fixed, the equation is linear, regardless of the nature of $F(t)$. Also, where M, D and K are functions of time (but are completely independent of x) the equation is also linear. However, where the coefficients vary with x, or with any of the derivatives of x, the equation and system are nonlinear. Figs. 2 and 3 illustrate several familiar linear and nonlinear systems, that point out the special features of each type.

The importance of this distinction between linear and nonlinear differential equations results from the intrinsic difference in the nature of their solutions, Table I. The critical feature is that the principle of superposition does not apply in the nonlinear case (or response is not proportional to excitation). This complicates the solution. In attacking a problem it is important to establish early whether it is essentially linear or nonlinear.

The difficulty of handling nonlinear situations has prompted engineers to make simplifying assumptions which ignore the nonlinearity. Hook's law of elastic strain, Newton's law relating force and acceleration, the perfect gas law and Ohm's law are examples of such approximations and give accurate results only under limited conditions of operation. Where the range of variation of parameters is within these limits, the approximations are satisfactory; however, where situations force designs beyond these conventional boundaries the linearized approximation to a nonlinear problem can give completely inadequate results, not only numerically, but even to the extent of missing entirely some significant aspect of the problem. The emphasis today is not only on understanding and compensating for the nonlinear by-products resulting from the extended range of system variables, but also on intentionally introducing nonlinearities to achieve performance beyond the theoretical limits of the linear problem. Table II covers the various basic types of nonlinearities that are most often encountered by designers.

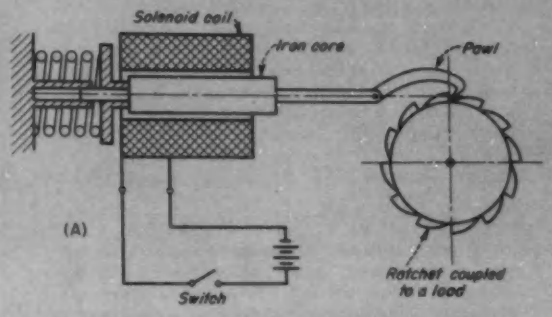
The solution to a nonlinear problem

Table I—General Comparison of Linear and Nonlinear Systems

1. Under conditions of steady sinusoidal excitation, linear systems respond sinusoidally. Nonlinear system response includes harmonics, and often subharmonics.
2. Under conditions of steady sinusoidal excitation, linear systems yield a unique response, whereas nonlinear systems may have several stable operating modes.
3. The principle of superposition applies only in linear systems.

TYPICAL NONLINEAR SYSTEMS

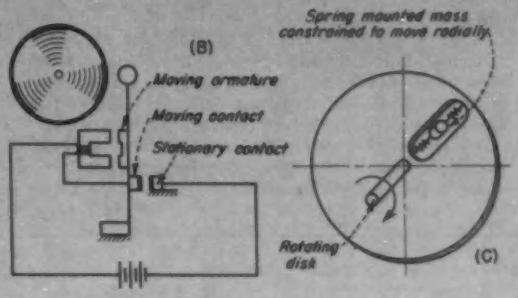
Fig. 3

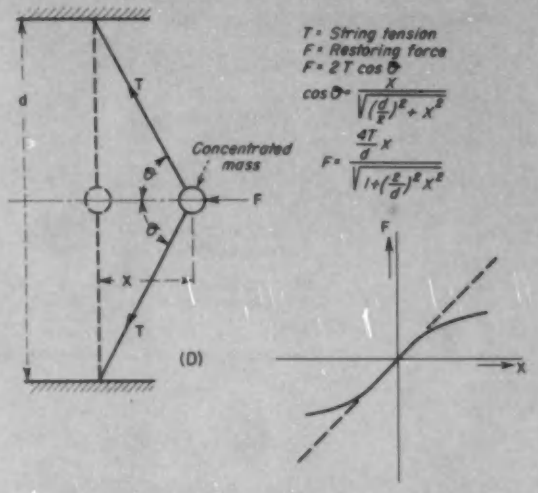


(A) Ratchet and pawl. Since the resistance to motion depends on the direction of motion, or, in other words, on the sign of the velocity, the system has nonlinear damping and is thus itself nonlinear. A similar dynamic analysis applies to many forms of unidirectional clutches and other devices.

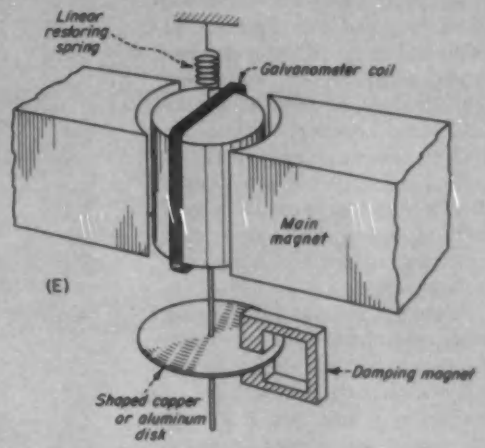
(B) Doorbell buzzer. Since the restoring force on the moving armature varies with armature position (changing sharply with the make and break of the electrical contact) the system is dynamically equivalent to a nonlinear spring.

(C) Mechanical systems with variable inertia. This complex system is nonlinear since the inertia of the rotating disk is a system variable, changing with angular velocity.





(D) Large amplitude vibration of a string with concentrated mass. Assume that initial string tension is high. Since restoring force varies less than proportionally with displacement, the system constitutes a "soft" spring and is nonlinear.



(E) Galvanometer type device with nonlinear damping. When used as a null detector, adequate damping is available near the null but negligible damping exists for large off-null positions. This permits rapid slewing.

(F) A worm gear and pinion favors the transmission of motion from the worm to the wheel and is only slightly reversible. This corresponds to a damping dependency on torque and the system is nonlinear.

(G) Nonlinear spring constant. The shaped contour introduces a precise variation in effective pendulum length with displacement. For a cycloidal contour, the arrangement becomes isochronous; that is, the period of oscillation is independent of amplitude. If the mass is fastened to its support by a flat leaf spring, it can be used as a wide range accelerometer since it is very sensitive to small accelerations and loses sensitivity under large accelerations. A similar device can be used as a nonlinear wide range scale for weighing.

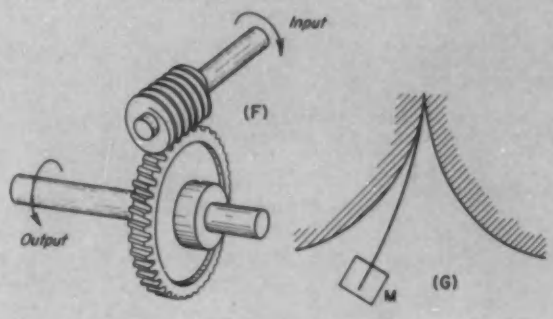


TABLE II—BASIC TYPES OF NONLINEARITIES

RESIDUAL NONLINEARITY. Present in the problem but ignored for analytical convenience. Appears in final product as a departure from predicted design and must be held within tolerable limits for satisfactory operation. This is most common variety of nonlinearity encountered by designers; for example, backlash in gearing, starting friction and the operation of elastic material beyond the proportional limit represent three typical residual nonlinearities. See Table III for a partial listing of the most often encountered electrical and mechanical residual nonlinearities.	**OPERATIONAL NONLINEARITY.** Devices whose operational principles depend on nonlinear elements, but which function as essentially linear components in systems. This classification includes such devices as commutator machines, vacuum tube amplifiers and oscillators, linear magnetic amplifiers, and vibrating relays. Not only do these devices require the attention of the component designer who must grapple directly with the nonlinearity but also of the systems designer who must take proper care in application to achieve essentially linear performance in the final operation of the system.
COMPENSATING NONLINEARITY. Nonlinearity intentionally introduced in a system to minimize the effects of residual nonlinearity. Typical examples are: the use of static friction to cancel out backlash nonlinearity, the introduction of a thermal cutout to minimize a nonlinear temperature effect, and the use of a variable length pendulum arm to compensate for the dependence of the period on vibration amplitude.	**BASIC SYSTEM NONLINEARITY.** The basic operation of many systems depends on nonlinear characteristics. Such systems cannot be considered linearly. Among the devices that fall into this classification are: relay controls and contactor regulators, saturable core voltage regulators, carbon pile regulators, pressure control valves, harmonic generators, and certain types of shock absorbers.

is generally quite difficult and is frequently impossible. Rarely is a closed form analytical solution obtainable, as for most linear problems. Care must be taken to determine allowable assumptions and simplifications that do not destroy the intrinsic nature of the solution. Many nonlinear designs are evolved by alternating sessions of experimental and analytical work. Often much effort must be expended merely to arrive at an analytical statement of the problem, let alone reach a solution. Thus the designer must not always expect a complete solution to nonlinear problems, and may have to be content with a qualitative knowledge of the phenomena under consideration.

In addition to the experimental approach (which serves as a guide in analysis), a number of specialized techniques for dealing with nonlinearities have been developed. Only those approaches that are based on physical reasoning rather than on advanced mathematics will be presented here. Included in this group are the phase-plane method and the electrical analogy method. While these methods do not constitute a generalized approach, they often indicate satisfactorily the nature of the physical phenomena. Many specific behaviorisms of nonlinear systems turn up again and again, and familiarity based on experience is a help in recognizing and handling these behaviorisms in new and different situations.

TABLE III—RESIDUAL NONLINEARITIES

MECHANICAL	ELECTRICAL
1. Backlash in gearing and couplings.	1. Saturating amplifiers.
2. Starting friction.	2. Nonlinear properties of iron core materials.
3. Compressibility of fluids in hydraulic systems.	3. Thermal sensitivity of resistors and electrical fuses.
4. Hydraulic leakage.	4. Hysteresis losses in ferromagnetic materials.
5. Nonlinear torsional characteristics.	5. Dielectric breakdown and leakage.
6. Excessively strained elements.	6. Generated noise in carbon and other resistors.
7. Mechanical hysteresis losses.	7. Variable dielectric constant of capacitor insulation (voltage sensitivity).
8. Worm gearing having unidirectional drive characteristics.	8. Torque limits of electrical motors, determined by magnetic core saturation.
9. Heavily strained columns.	9. Carbon brush voltage drop on d-c machines.
10. Unbalanced shaft inertia load causing variation of effective inertia with position.	10. Amplifier distortion.
11. Gearing having eccentric pitch diameter or poorly formed teeth.	11. Harmonic generation in ferromagnetic chokes.
12. Friction in coils of loaded spring.	12. Contact bounce in wire-wound potentiometers.
13. Thermal expansion because of frictional heat in machine parts.	

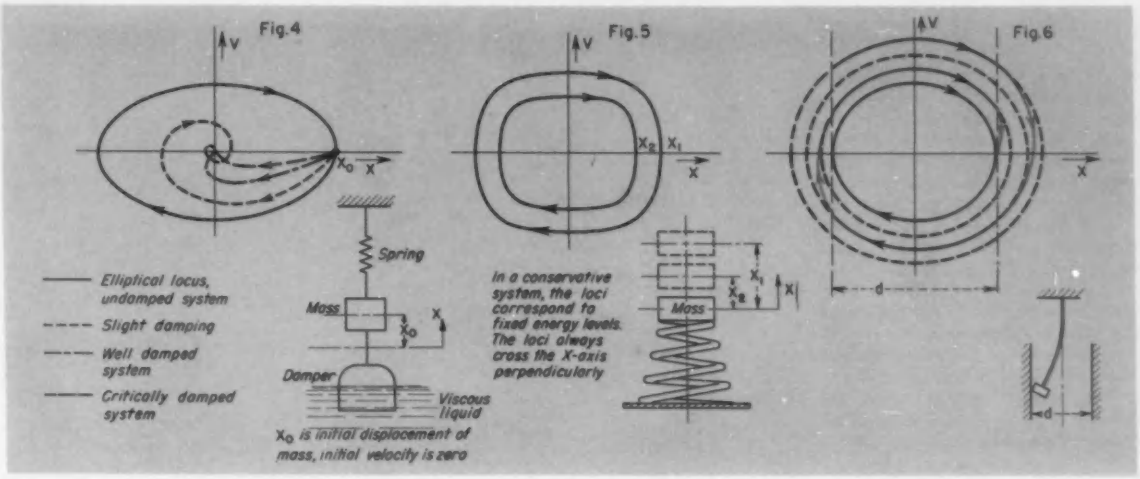


Fig. 4—Linear system phase portrait of system shown in Fig. 1. As mentioned, there are many physical systems that follow the same basic laws as this system. With no damping the system will continue to oscillate with an amplitude of $2x_0$ as shown by the elliptical locus. The introduction of linear damping reduces the number of oscillations to rest. With critical damping the mass will not oscillate at all but will come directly to rest. Thus, phase-plane plots clearly show the effect of parameter variation on system performance.

Fig. 5—Conservative (undamped) system with nonlinear spring. Spring force increases more than proportionately with displacement accounting for the squared rather than elliptical shape of the phase portrait. "Hard" springs such as this with limit stops and damping are used in shock absorbers. With increasing load the spring constant increases, maintaining the system frequency characteristics independent of the load. Thus, because of nonlinearity, the frequency response of this type absorber is a function of disturbance amplitude.

Fig. 6—Phase portrait of oscillating mass contrained between two rigid stops. Elastic losses keep reducing the rebound velocity until in the limiting case, the phase portrait locus becomes the small ellipse. Colored connecting lines are imaginary and represent the reduction in rebound velocity each time the mass strikes one of the limit stops. Amplitude of small ellipse is established at point where mass no longer strikes limit stops. Note resemblance of the constrained motion locus to the hard spring pattern of Fig. 5.

Solving Nonlinear Problems by the Phase-Plane Method

In the initial study of a nonlinear problem it is advantageous to consider some simplified system that incorporates the key nonlinear feature. External forces or voltages are usually ignored and the free dynamics of the system are isolated. Often considerable information can be obtained by assuming that the nonlinearity itself is small, but not negligible. The knowledge gained from this simplified analysis serves as a guide in understanding the performance of the actual system.

Applying this approach to the dynamic system shown in Fig. 1:

$$M\frac{d^2x}{dt^2} + D\frac{dx}{dt} + Kx = 0 \quad (2)$$

Let M, D and K be functions of x and/or functions of its derivatives. Depending on which coefficient varies, and on the nature of the variation, a degree of standardization has been achieved in the solution of this equation. A variety of these "standard" solutions will be presented as typical methods of nonlinear analysis.

Assume that D is a function of velocity, $D\left(\frac{dx}{dt}\right)$ and that K is a function of displacement $K(x)$. Represent $\frac{dx}{dt}$ by V. The equation then becomes

$$M\frac{dV}{dt} + D(V) \cdot V + K(x) \cdot x = 0$$

Solve for $M\frac{dV}{dt}$ and divide by $\frac{dx}{dt}$

$$M\frac{\frac{dV}{dt}}{\frac{dx}{dt}} = \frac{-D(V) \cdot V - K(x) \cdot x}{\frac{dx}{dt}}$$

$$M\frac{dV}{dx} = \frac{-D(V) \cdot V - K(x) \cdot x}{V} \quad (3)$$

Thus differential Eq (3) relates V and x and has no time variable. This equation can always be solved, at least by graphical methods. The loci of solutions corresponding to various initial conditions can be plotted in the x-V plane, or "phase plane". Phase-plane plots or "phase portraits" represent the performance of a dynamic system; and because of the visual nature of the information they present, are a useful tool in system synthesis. Fig. 4 through 8 show phase portraits of both linear and nonlinear dynamic systems.

It is often useful to determine the response of a dynamic system to a suddenly applied force of constant amplitude (step function). This can be done by shifting the force to the left side of the basic Eq (1), so that in effect it becomes part of the spring constant.

$$M\frac{d^2x}{dt^2} + D\frac{dx}{dt} + Kx = F$$

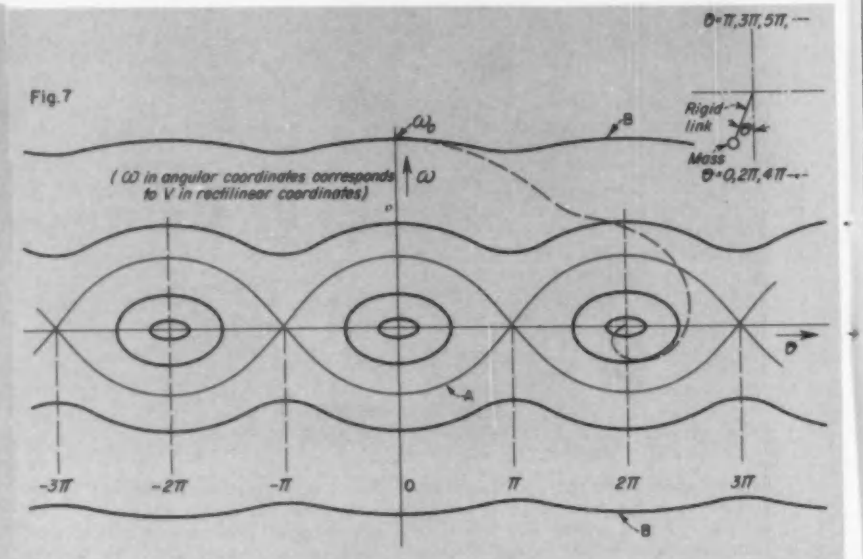
$$M\frac{d^2x}{dt^2} + D\frac{dx}{dt} + (Kx - F) = 0 \quad (4)$$

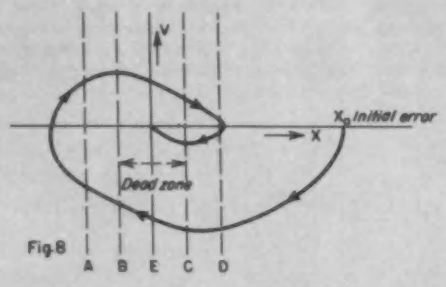
In Fig. 9 is shown the effect of a step function applied to a spring mass system.

From these examples it can be seen that the phase portrait is a powerful tool in the investigation of nonlinear phenomena, especially where the system undergoes discontinuities. Many special components of modern control systems

Fig. 7—Phase portrait of a rigid pendulum. Solid lines represent undamped response; dotted line damped response. The pendulum behaves like a nonlinear spring. Note that there are an infinite number of stable equilibrium points at 0, plus or minus 2π, plus or minus 4π, etc. Likewise, there are an infinite number of points of unstable equilibrium at plus or minus π, plus or minus 3π, etc; corresponding to a vertical position of the pendulum. When the energy level exceeds a value corresponding to the critical curve *A*, the pendulum will rotate with an undulating velocity. Cross-over points such as π on curve *A* always represent points of unstable equilibrium in phase portraits.

The dotted curve shows the locus of a pendulum oscillation with damping. The initial velocity, ω_0, is sufficient to flip the pendulum over once, allowing it to come to rest at 2π. Without damping a pendulum with initial velocity ω_0 would follow curve *B*.





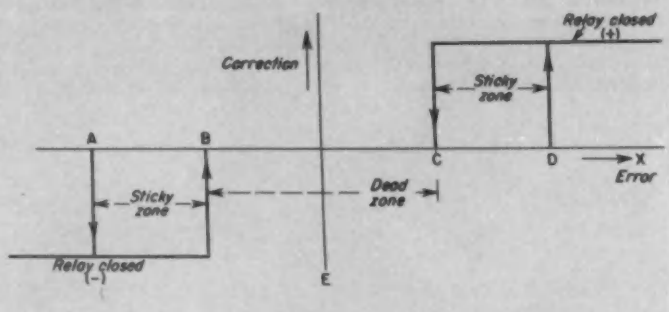
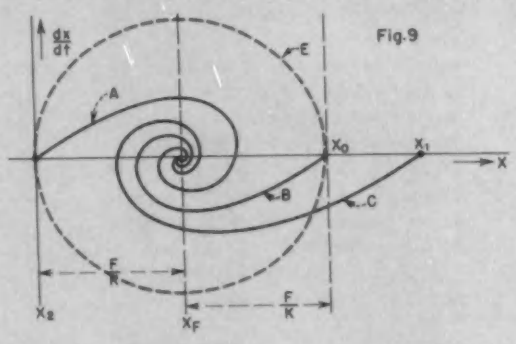


Fig. 8—Phase portrait of an oscillating relay servomechanism including relay hysteresis and damping. Curve represents the dynamic response of the servo output member. An initial error of x_0 is sufficient to energize the relay and a restoring force accelerates the output towards the null position. The system oscillation alternately energizes and de-energizes the relay at x_0, *C*, *A*, *B*, *D*, *C*, and then to stable equilibrium. Viscous damping acts on the output and is sufficient to restrict the response to one negative and one positive overshoot before settling at the balanced position. This characteristic phase portrait is applicable to many other types of on-off devices; such as, thermostats and certain types of speed governors.



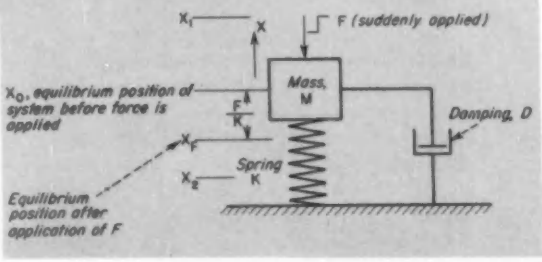


Fig. 9—Phase portrait of response of spring-mass system to a step function. Curve *A* represents response of damped system when force is amplied with mass displaced a distance $2F/K$ below the normal equilibrium position, x_0. Curve *B* represents damped response when force is applied with mass at x_0, and curve *C* when mass is initially displaced upward to point x_1. Curve *E* represents response of undamped spring-mass system to a step function.

Fig. 10

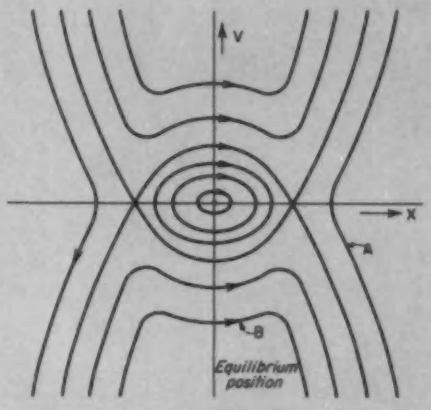
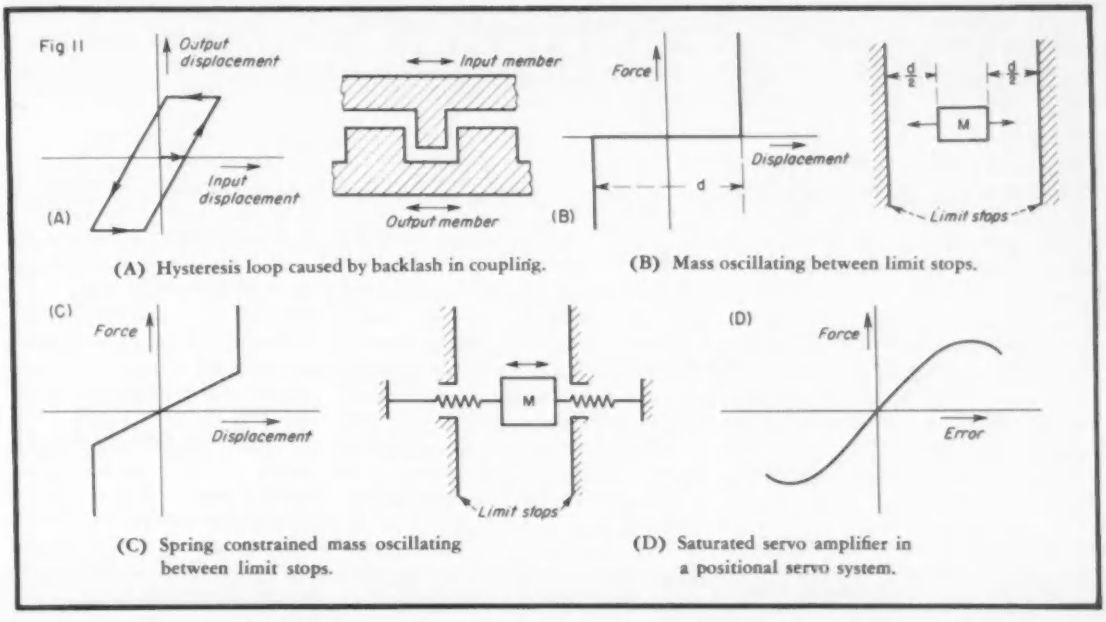


Fig. 10—Phase portrait of an undamped oscillating mass constrained by a spring having decreasing spring constant with displacement (soft spring). Given sufficient kinetic energy, curve *B*, or sufficient initial displacement, curve *A*, the spring is unable to restore the mass to equilibrium. Since the spring constant decreases with increased amplitude, the natural frequency of the system also decreases with increased amplitude. Typical of soft spring performance is the action of a proportional servo in the presence of control amplifier saturation, or the behavior of a metallic member beyond its yield point. Soft springs having restoring force independent of or decreasing with amplitude are available.

Table IV—Nonlinear Spring Functions

MECHANICAL	ELECTRICAL
1. Anti-backlash gearing.	1. Synchronous machine torque characteristics.
2. Gearing containing backlash.	2. Nonlinear amplifier in a servo loop.
3. Shaft highly stressed in torsion.	3. On-off correction devices.
4. Gear teeth having imperfect contour, eccentric pitch line or tooth resilience.	4. A-c circuit containing iron core inductance.
5. Motion confined by limit stops.	5. Motion in an inverse square law field.
6. Pendulum motion.	6. Torque saturation of an electric motor.
7. Elastic deflection of some cantilever beams, columns, and other elastic members.	7. Capacitor having a voltage sensitive dielectric such as barium titanate.
8. Oscillation of a floating body of arbitrary shape.	8. Capacitance amplifiers.
9. Imperfect pin coupling between shafts.	9. Cogging of electric motors caused by rotor slots.
10. Nonlinear shock absorbers.	
11. Spring coupled misaligned shafts.	

Typical Nonlinear Spring Characteristics Encountered in Physical Systems



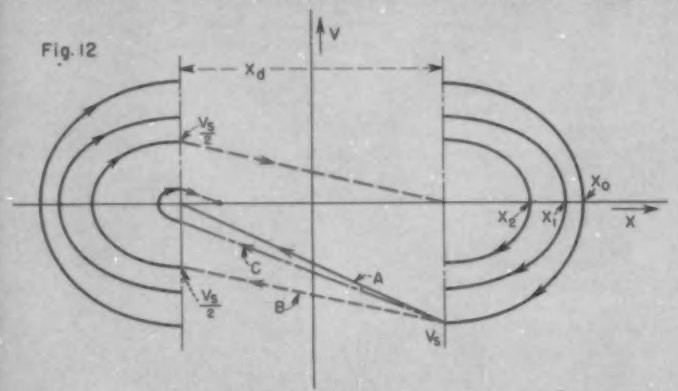
(A) Hysteresis loop caused by backlash in coupling.

(B) Mass oscillating between limit stops.

(C) Spring constrained mass oscillating between limit stops.

(D) Saturated servo amplifier in a positional servo system.

Fig. 12—Phase portrait of on-off servomechanisms with dead zone and no relay stickiness. For simplicity damping is neglected except in the dead zone. With the relay de-energized the locus follows a straight line (dead zone performance). Equation expresses condition for no overshoot when servo pulls into dead zone at maximum motor speed, curve *A*. Note that servo just stops at other border of dead zone under this condition. Curve *B* shows performance with minimum damping for one overshoot. Servo output overshoots once and stops at dead zone border on right. Note that minimum damping for this condition is one-half that for no overshoot (slope of *B* is one-half slope of *A*). x_o is minimum error that will allow output to achieve maximum speed by the time the dead zone is reached. Initial errors x_1 and x_2 do not allow output to reach maximum speed. The dead zone determines the system error and should be minimized for accuracy. However, this increases damping problem if number of overshoots is to be kept low. The dependence of the response on the initial error amplitude is characteristic of nonlinear systems.



Dynamic equation for dead zone performance with no overshoot
K=0 since relay is de-energized
V varies linearly with X

$$M\frac{d^2x}{dt^2} + D\frac{dx}{dt} = 0$$

$$\frac{dV}{dt} = -\frac{D}{M}\frac{dx}{dt}$$

$$DM = M\frac{V_s}{X_d}$$

Where:

V_s = *maximum motor speed*

X_d = *width of dead zone*

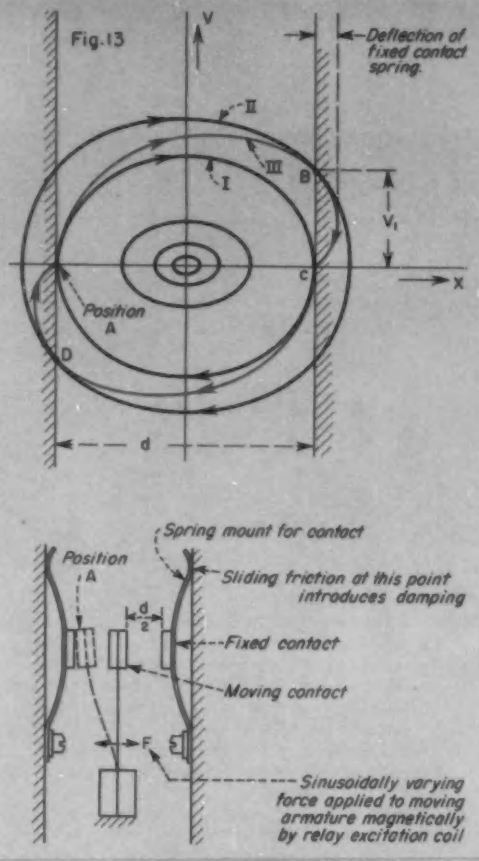


Fig. 13—Phase portrait of oscillating relay armature with contact damping. A typical operating cycle starts with the contact at rest at position *A*. The contact is accelerated by the magnetic force *F* from curve I to position *B* on the higher energy curve II. Thus contact follows curve III. The fixed contact is struck with a velocity V_1, corresponding to an amount of kinetic energy to be dissipated by sliding of the fixed contact spring. The required friction to bring the rebound velocity to zero at position *C* must increase as the stiffness of the spring increases for complete dissipation of energy.

(brakes and clutches, contactors, and regulators) can be studied by this technique. Unfortunately, it is limited to second order systems although recently efforts have been made to extend it generally.

A simplified analysis can often be performed by initially neglecting dissipation (assuming *D* equals 0) and then later incorporating the damping characteristic as a modification to the original solution.

For example, for zero damping the basic equation becomes

$$M\frac{dV}{dt} + K(x) \cdot x = 0$$

$$M\frac{dV}{dx} = \frac{-K(x) \cdot x}{V}$$

$$M\int_{V_o}^{V} V\,dV = -\int_{x_o}^{x} K(x) \cdot x\,dx$$

$$\frac{M}{2}(V^2 - V_o^2) = -\int_{x_o}^{x} K(x) \cdot x\,dx \quad (5)$$

In Fig. 10 is shown the phase portrait of an oscillating mass constrained by a soft spring whose spring constant decreases with amplitude. Once the nature of the oscillation is determined for the conservative (undamped) case by the integration technique indicated in Eq (5), the effect of various types of damping can be roughly superimposed. The integration technique can be applied to any arbitrary spring constant variation. Fig. 11 shows some specific modes of variation that are frequently encountered (also see Table IV). For a pendulum, an exact integration would lead to an elliptic integral.

An additional special technique that can be used to advantage in approximating solutions is based upon conservation of energy. Fig. 12 shows the amount of viscous damping that would be required to avoid overshoot and achieve critical damping in an oscillating relay regulating device. Likewise, the maximum damping that will just sustain oscillations in the presence of a specified relay stickiness can be approximated. The contactor damper of Fig. 13, which is used to reduce relay contact bounce, can be adjusted according to the phase plane anlysis.

Solving Nonlinear Problems by Electrical Analogy

A convenient way to solve mechanical, thermal and other nonlinear problems is by studying the electrically analogous system. The refined methods of electrical analysis, the compactness of notation, and the ease of electrical experimentation have made this procedure very useful.

The ultimate in the use of analogous systems is the analog computer, which can solve problems in mechanics, thermodynamics, fluid flow, electronics and nucleonics. Most general purpose analog computers incorporate special function generators to be used in the solution of nonlinear problems. Where the system under study is at all complex (high order differential equation) and a quantitative understanding coupled with a clear physical picture is required, the analog computer becomes essential.

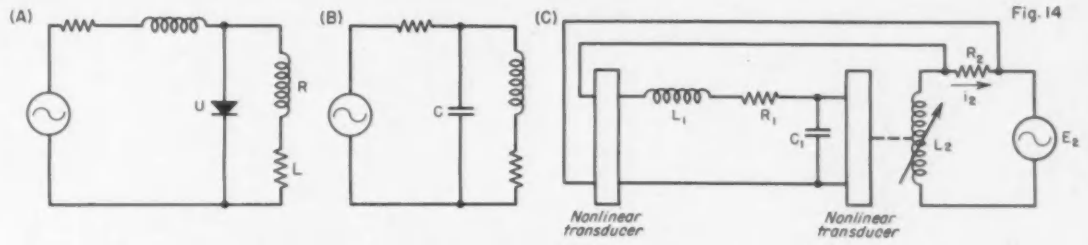
In Table V is listed some common diode circuits used for the generation of nonlinear functions. By combining these circuits with amplifiers a large variety of functions can be developed. High accuracy is not required in most of these circuits since the nonlinear phenomena themselves can rarely be defined exactly.

The analogs shown in Table V are suitable for the direct solution of differential equations where the independent variable is a function of time. Another type of analogy can be established in many instances where a direct correspondence can be made of individual circuit elements and the elements of the analogous system. This latter form of analogy is useful in visualizing a nonlinear relationship, and often putting the system down in convenient electrical notation will suggest the answer.

One set of basic mechanical-electrical analogies are as follows:

$$\left.\begin{matrix}\text{mass}\\ \text{inertia}\end{matrix}\right\} \equiv \text{inductance}$$

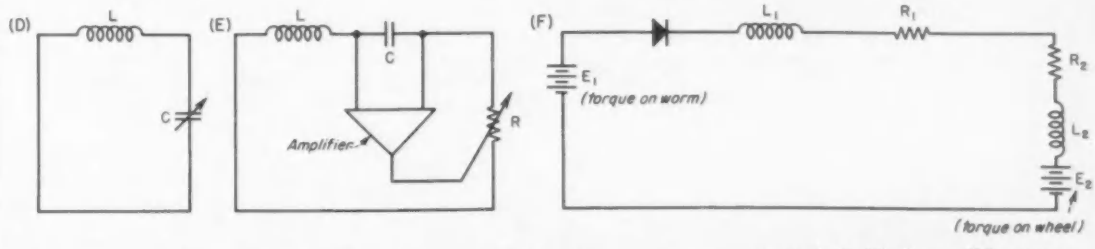
Analogs to Nonlinear Mechanical Systems Shown in Fig. 3



(A) Compare with mechanically equivalent ratchet and pawl, Fig. 3(A). L and R correspond to inertia and drag caused by the load on the ratchet. This is a condition of nonlinear damping since circuit resistance (including rectifier, U) depends on the sign of the current (corresponding to the velocity).

(B) Doorbell buzzer equivalent, Fig. 3(B). C alternates between zero and infinity, corresponding to armature position while opening or closing the electrical contacts. This is a condition of a nonlinear spring.

(C) L_1, R_1 and C_1 correspond to the mass, friction and spring of the mass of Fig. 3(C). Radial position, which corresponds to charge on C_1, controls inductance of L_2 which in turn represents effective inertia. The current i_2 corresponds to angular velocity, and is measured by drop across R_2. A nonlinear transducer converts to voltage (centrifugal force) across L_1, R_1 and C_1.



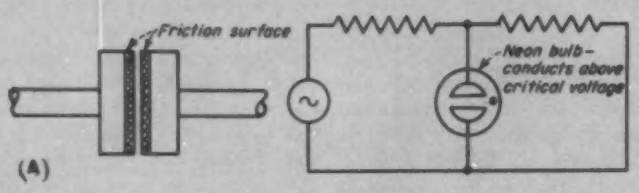
(D) Corresponds to nonlinear spring systems of Fig. 3(D) and (G). In the first instance, Fig. 3(D), C increases with charge; in the second instance, Fig. 3(G), it decreases.

(E) Analogous to damped galvanometer device of Fig. 3(E). This is an unusual example where damping is a function of position as well as velocity. The amplifier measures capacitance charge (corresponding to displacement) and varies R to suit.

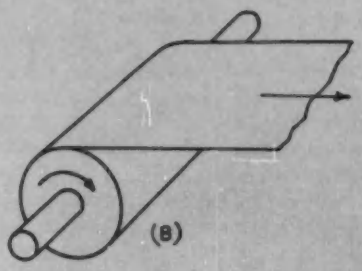
(F) Approximate equivalent circuit of worm wheel, Fig. 3(F). L_1, R_1, L_2 and R_2 correspond to the inertia and damping of the worm and wheel respectively. The irreversible nature of the worm wheel transmission is introduced by the rectifier which only permits current flow in one direction. Where some reverse transmission is possible a leaky rectifier can be used. Note that high transient voltages (or torques) can be developed when switching loads.

Fig. 15

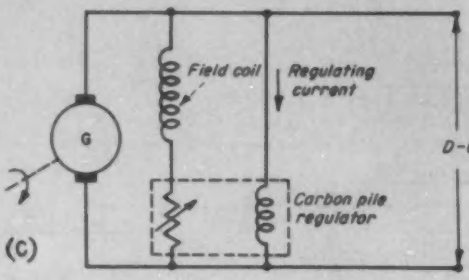
MISCELLANEOUS NONLINEARITIES



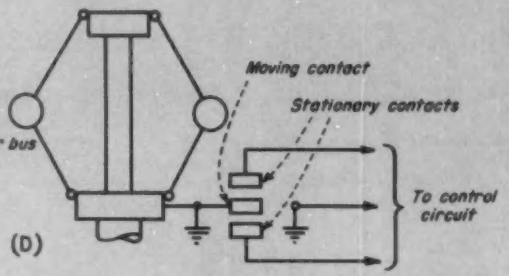
(A) Slip clutch and equivalent electrical circuit. Transmitted torque is high for zero relative velocity, but decreases sharply in the presence of relative motion. System exhibits nonlinear damping characteristics.



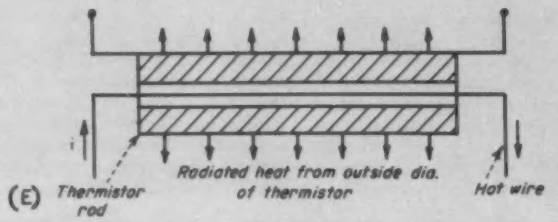
(B) Sheet material unrolls with shaft rotation. Example of nonlinear system having inertia as a function of shaft position.

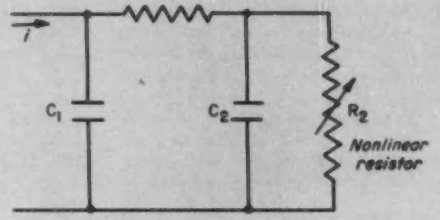


(C) As the regulating current increases because of an increase in bus voltage, the carbon pile resistance is also increased, thereby reducing field coil current and restoring bus voltage. Another example of nonlinear damping.



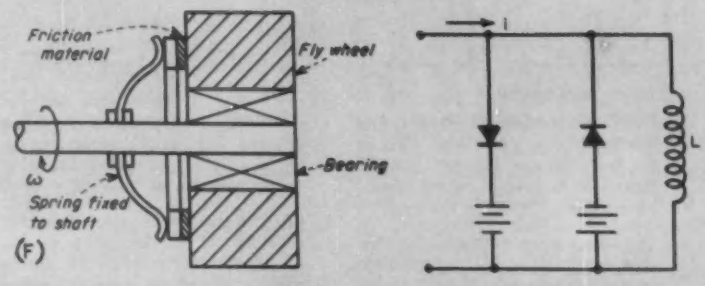
(D) Flyball speed regulating device actuating relay controller. Shifts in speed cause one or the other fixed contact to close and results in the application of a speed-restoring force. Damping is nonlinear.

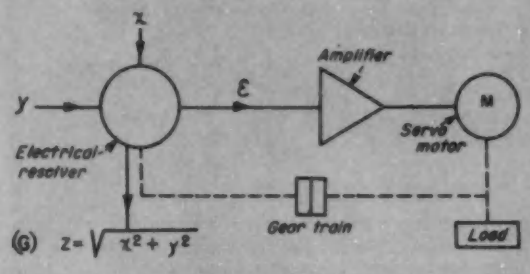




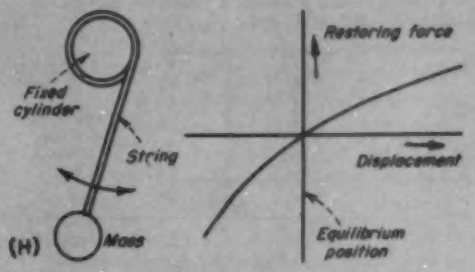
(E) Hollow thermistor rod heated by hot wire with equivalent electrical circuit. The input current, i, to the equivalent thermal circuit supplies coulombs of charge analogous to calories of heat. Condensers C_1 and C_2 are analogous to the thermal capacities of the hot wire and thermistor respectively. R_2 is a nonlinear resistor that corresponds to the radiation resistance of the outer surface of the thermistor. Voltage is equivalent to temperature. The current through R_2 varies as the fourth power of the voltage across it.

(F) Lanchester damper and equivalent electrical circuit. This device is used for damping vibrations. Friction is maintained at a fixed magnitude by choice of suitable friction coupling materials. Current, i, in equivalent circuit corresponds to shaft velocity, ω. Inductance, L, corresponds to flywheel inertia.



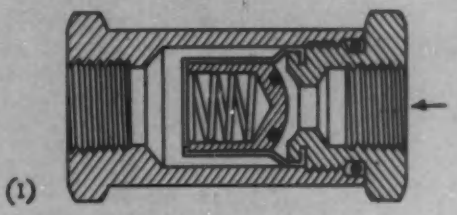


(G) The error voltage from the electrical resolver equals Z times the sine of the angle off null. Thus, loop gain varies with X and Y. Since gain is function of the inputs, the servo is nonlinear.



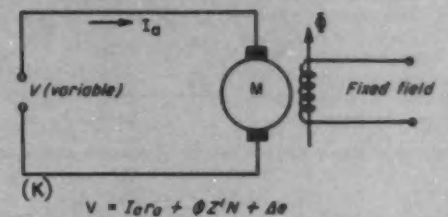
(H)—Pendulum system in which string is wrapped around a fixed cylinder. This gives a nonlinear unsymmetrical spring constant as shown by the curve.

(I) Hydraulic rectifier or check valve. This is nonlinear as is an electrical rectifier since flow depends on polarity or direction.



(J) Spring loaded friction brake and equivalent circuit. Relaxation oscillations such as are generated in the neon bulb circuit also occur in the stationary shaft and spring of braking devices because of the greater value of starting over running friction (nonlinear friction). To minimize the mechanical oscillations, the torsional rigidity of the spring and shaft should be high.

(K) Nonlinearity in open loop armature speed control circuit. In addition to the lack of proportionality between V and N, the response of the magnetic circuit to the armature reaction field adds another nonlinear complication in this application.



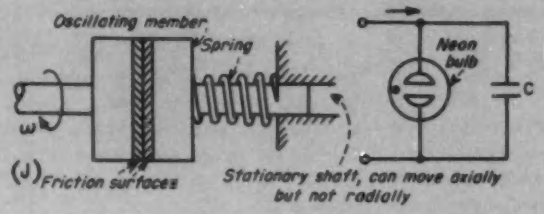
$V = I_a r_a + \phi Z' N + \Delta e$

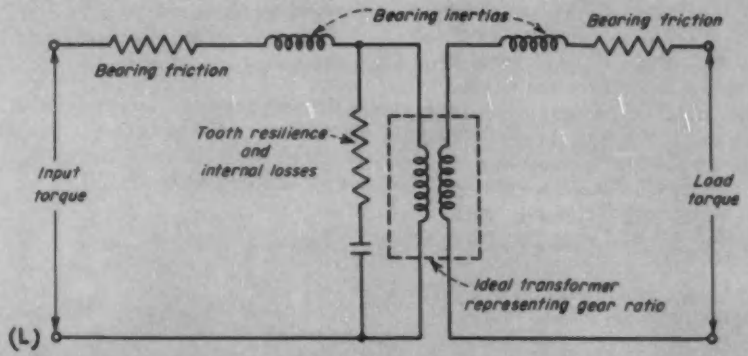
r_a = armature resistance

Z' = proportionality constant

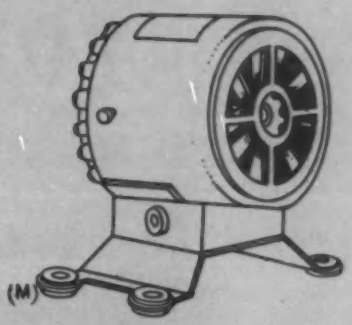
N = rpm

Δe = brush drop (constant, about 2 volts in commercial machines)





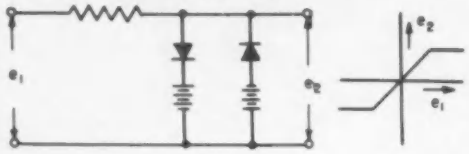
(L) Equivalent circuit of a gear train. Many of the components in this circuit are frequently nonlinear. The bearing friction equivalent circuit can be represented by coulomb friction circuit shown in Table V (A). Backlash in gearing requires capacitor to alternate between zero and infinity.



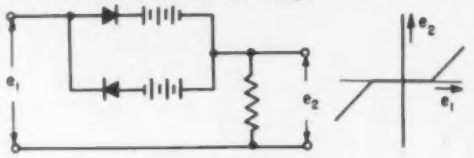
(M) Electric motor with fan cooling. Besides causing a nonlinear drag on the motor, fan cooling causes temperature rise to vary in a complex manner with speed and load. In small motors, the cooling effect of a fan must be weighed against the reduction in available motor length and the loss in available torque. In designing to meet specific duty cycles, the differential relations can be sharply nonlinear.

Table V—Typical Diode Circuits for the Simulation of Nonlinear Functions

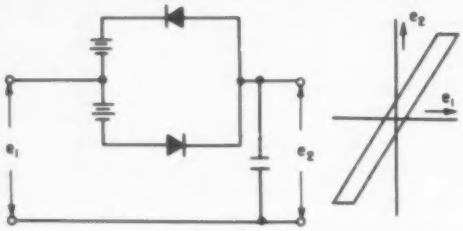
A—Limiter Circuit. This circuit arrangement can be used to represent coupling by coulomb friction, amplifier saturation or speed regulation.



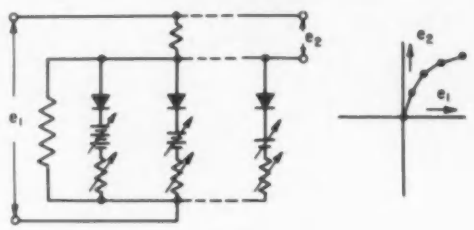
B—Dead Space Simulator. Can simulate the low signal operation of a system where noise or static friction limit the sensitivity.



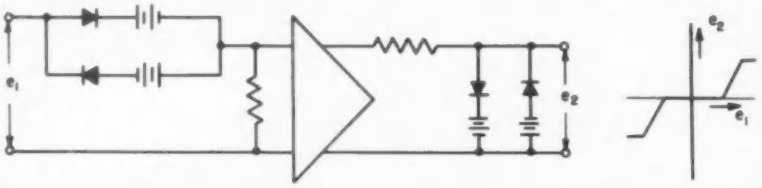
C—Backlash Simulator. Represents such phenomena as gear backlash and certain thermal variables.



E—General Function Circuit. This can be used to simulate any variety of soft spring.



D—Combination Simulator for Special Functions. Combination of limiter and dead space simulator with high-gain amplifier to improve response. Will duplicate characteristic variations such as clutch torque with signal voltage.



viscous drag ≡ resistance
spring constant ≡ reciprocal capacitance or elastance
force, torque ≡ voltage
displacement ≡ charge
velocity ≡ current

When electrical and mechanical systems are compared, parallel sets of differential equations can be set up using analogous units as listed above. This is the justification for the use of analogs. The high degree of refinement achieved in electrical analysis, synthesis and filter theory permits the designer to apply electrical theory in extending nonelectrical concepts. Even distributed constant circuits have their counterpart in mechanical strain problems.

Other electromechanical analogies than those presented above are possible, and, in addition, thermal-electrical analogies can be set up as shown in Fig. 15 (E). A complete set of equivalent electrical circuits for a wide variety of electrical machines has been derived, including applications where severe electrical and mechanical unbalance is prevalent. Equivalents have also been derived that are useful in solving problems in thermodynamics and nucleonics.

Often, an equivalent electrical circuit will not contain all three types of electrical elements (resistance, inductance and capacitance). In arranging such circuits, convenient substitutions can be made to obtain simpler experimental set-ups. For example, in a circuit containing inductance and resistance, resistance capacitance may be used with the object of reducing cost and complexity by avoiding the use of chokes. For logical and accurate results, it is necessary to use care in the interpretation of results. When in doubt, the differential equations should form the basis of comparison.

Using these analogs the electrical systems of Fig. 14 are equivalent to the nonlinear mechanical systems of Fig. 3. The ease of making oscilloscope measurements under steady and transient conditions, and the rapidity with which systems can be set up and modified are important advantages of the analog approach. A variety of electromechanical components and function generators is available for use in analog computers. Included are nonlinear potentiometers coupled with cams and linkages, tapped and loaded linear potentiometers and devices based on the properties of photocells.

As a further assist in the recognition of nonlinear phenomena, Fig. 15 shows additional commonly encountered nonlinear devices.

Acknowledgment: The author wishes to thank Mr. Alfred Gronner of the American Machine and Foundry Co. for valuable criticism and advice.

REFERENCES

1. *Electronic Analog Computers*, G. A. Korn and T. M. Korn, McGraw-Hill Book Co., Inc., 1952.

2. *Nonlinear Vibrations*, J. J. Stoker, Interscience Publishers Inc., 1950.

3. *Equivalent Circuits of Electric Machinery*, Gabriel Kron, John Wiley and Sons, Inc. 1951.

4. *Introduction to Nonlinear Mechanics*, N. Minorsky, Ann Arbor, 1947.

5. *Introduction to Nonlinear Mechanics*, N. Kryloff and N. Bogoliuboff, Translated from Russian by S. Lefschetz, Princeton University Press, 1943.

Pre-Coated Copper for Printed Circuit Manufacture

IN THE MANUFACTURE of printed circuits, the problem has always been to get a uniform bond between the copper sheet and the base. Going still further, this problem is divided into: (1) the cleaning of copper sheet before the adhesive is applied; and (2) the uniform reliability of the adhesive.

Recently, the steps of production of these copper laminated sheets were reduced from eight to two. With the development by the Rubber and Asbestos Corp. of the Plymaster type N and type E, a new synthetic elastomer with a thermosetting resin, cut-to-size copper sheets can be sent from the mill, cleaned, and pre-coated with adhesive. The manufacturer then: (1) lays the adhesive-coated copper sheet on the impregnated paper or previously formed laminate; and (2) sets in a heated press for curing and final lamination.

Next, the portions of this top copper layer are etched away to leave the printed circuit on one or both sides of the base board. The entire base board is subsequently dipped into a bath of molten solder at either 390 F or, preferably, at 450 F. The molten solder adhers only to the copper lines which remain on the board.

The molded resin-impregnated insulating board that makes up the base of the printed circuit is made to varying specifications according to NEMA Standards for Laminated Thermosetting Sheets. At the present time, three different types of base board compositions are in use. Phenolic Resin: has good general properties and higher structural strength than silicone. Also has lower heat resistance than either silicon or epoxy. Epoxy: has higher structural strength than phenolic resin or silicone. Heat resistance is higher than phenolics, but lower than silicone. Silicone: far higher heat resistance than either phenolics or epoxy; lower structural strength and higher cost than either phenolic or epoxy.

The polished electrolytic copper sheet, as produced by Anaconda Copper to meet RCA specifications K-989-912, is available in two thicknesses: (a) 0.00135 in., referred to as "one ounce"; and (b) 0.00270 in., referred to as "two ounce." This designation is based upon the weight of the individual sheet per square foot. Most sheet copper is shipped in rolls of 37, 38, 40 or 41 in. widths, and is cut by the user into the required lengths.

While the new adhesive-clad copper is more expensive than the unclad, savings of up to 75 percent are possible in the production of copper laminated bases for printed circuits, because of the elimination of the extensive cleaning and subsequent coating operations. Also, bond strengths up to 583 percent greater than previously used formulations are possible.

Peel strengths range from 10 to 12 lb per in. for the new type N adhesive, which passes the 390 F solder dip test, and from 15 to 35 lb per in. for the new type E adhesive, which passes the 450 F solder dip test.

Fig. 1—In the completion of this "sandwich," the adhesive coated side of the electrolytic sheet copper faces down, coming in contact with the resin impregnated paper.

Fig. 2—The finished assembly, protected against abrasion in the press, is inserted into the heated press for curing and final lamination. Depending upon the requirements, the base may be copper clad on one or both sides.

Fig. 3—The final copper clad laminate is cut to size.

Special Treatments for
WOOL FELT

Engineers are taking advantage of special felts designed to meet individual specifications and perform functions not possible with other materials. This trend has been spurred by the use of special treatments which add several desirable properties.

LEON D. GRUBERG
The Felt Association

THE BROAD AND EXACTING demands placed upon modern materials have, in the case of felt, necessitated supplementary properties in addition to those of resiliency, porosity, strength and stability. Felters have responded with a formidable list of treatments, each designed to answer a specific need.

Although individual requirements vary from industry to industry, it is possible to classify the many treatments into the following groups: impregnations, proofings, coatings, and laminations. Various impregnations and proofings are applied to standard roll felts available in widths of 54, 60 or 72 in. and up to an inch in thickness. Coatings and laminations are generally associated with standard sheet felts, which are the denser grades available in widths up to 36 in. and thicknesses to three inches.

IMPREGNATIONS. Depending upon the properties desired in a given application, felt is impregnated with one or more of a variety of substances including adhesives, asphalt, graphite, paraffin, wax of various kinds, natural and synthetic rubber, copper chromate and thermoplastic resins. Table I is a classification of treatments, their characteristics and uses.

One of the important developments in the field of impregnations is pressure-sensitive, adhesive-backed felt, now widely used for both civilian and military purposes. Grades of felt varying from SAE-F-10 to SAE-F-15 are given a "hot-melt" impregnation, followed by a brief drying cycle. A pressure-sensitive adhesive is then sprayed on the surface and subjected to an accelerated drying operation. About half the felts so treated are slit to standard widths for large-volume usage. Much of the remainder is made up as special strips or rolls in any width from $\frac{1}{4}$ to 36 inches.

There are a number of reasons why pressure-sensitive felts are used for sealing and gasketing. When subjected to pressure, the surface adhesive is forced into the mass of felt fibers. Thus, when applied between flanges, or at lapped or butted joints, the felt

FELT impregnated with various resins, plasticizers, pigments and chromates is non-corrosive and formulated to meet certain government specifications. Duct gasketing is typical of many cut parts; strips are also available.
Products Research Company

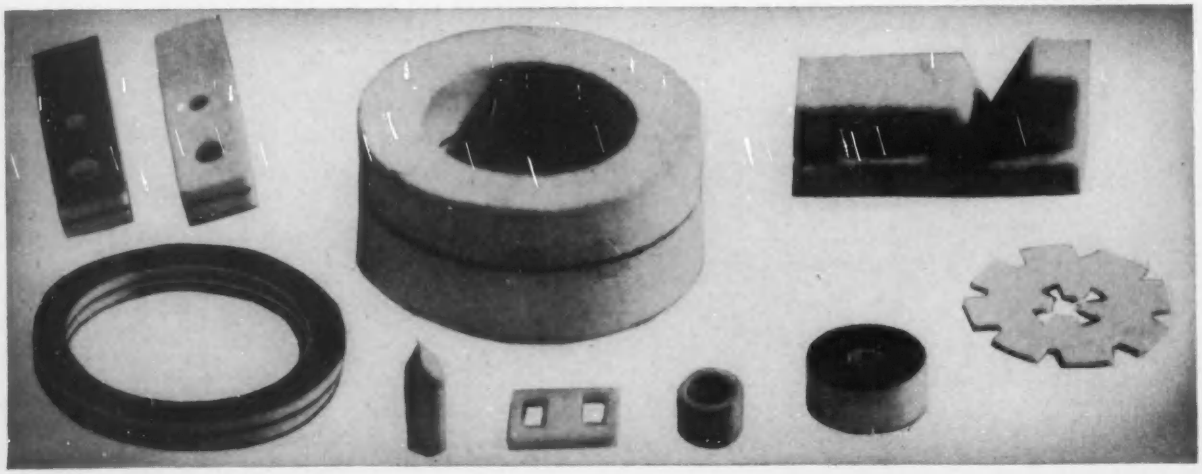
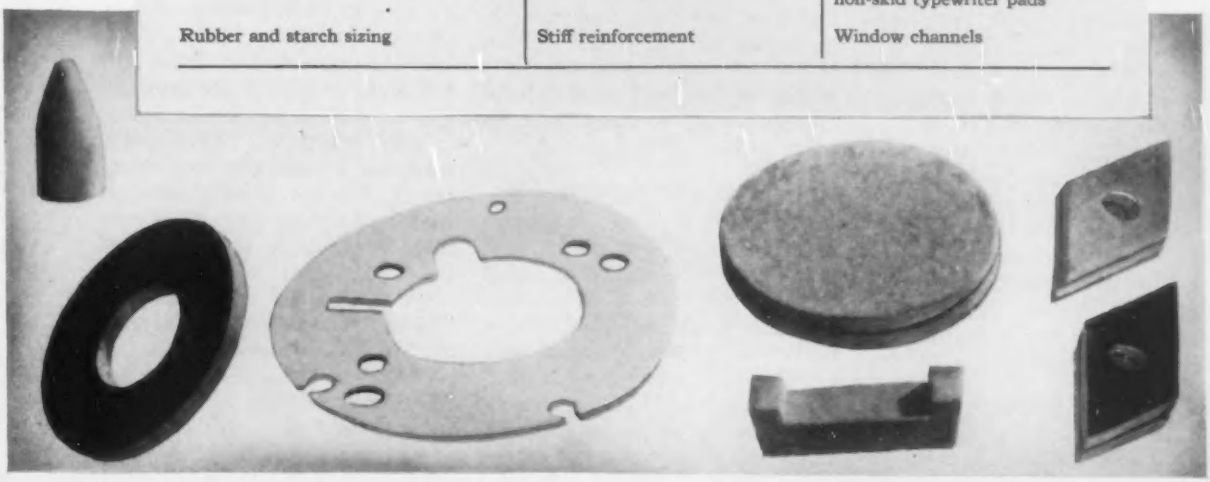


Table I—Typical Felt Treatments

Treatment	Special Properties	Applications
IMPREGNATIONS		
Asphalt (water dispersed)	Weather resistance	Cowl seals; anti-squeak chassis strips
Graphite (water dispersed)	Lubrication	Anti-friction lubricating pads, washers, oil seals
Paraffin-petrolatum (cut parts only)	Waterproofing, lubrication	Float-valve plunger washers, needle lubricating pads
Paraffin-graphite—petrolatum (cut parts)	Packing, lubrication	Marine stuffing box washers
Wax—Bee's, Carnauba, Candelilla (cut parts)	Blocking, sealing	Polishing laps; waterproofing
Natural rubber, Hycar, neoprene and Buna-S	Flexible stiffening and strengthening	Backing and cushioning felts. (Type of latex dependent on conditions of use.)
PROOFINGS		
Various neutral phosphates, borophosphates, ammonium sulfamate, ammonium phosphate, and mixtures of same. (a)	Flame resistance	Aircraft, clothes dryers, decorative
Dihydroxydichlorodiphenylmethane, salicylanilide, sodium pentachlorophenate, copper-8-quinolinolate, rosin amine D. (b)	Fungi resistance	As required by conditions of use
Various compounds of (a) and (b) above. (c)	Flame and fungi resistance	Acoustical and thermal insulation
Wax dispersions, WRX and aluminum salt emulsions, WRX and metallic salt compounds, aluminum stearate, zirconium compounds. (d)	Water resistance	Weather stripping
Various compounds of (b) and (d) above.	Moisture and fungi resistance	Tropical equipment
Silicofluorides, tarter emitic, dinitro-a-naphthol, fluorides and phenols.	Vermin resistance	Musical and scientific instruments; case linings
LAMINATIONS		
Rubber, Hycar, neoprene, Buna-S sheeting	1/32 and 1/64 in. impervious septums	Oil or water seals and washers
Aluminum or lead foil on pad felts	Special properties of foils	Reflectant, acoustical and thermal insulating blankets
COATINGS		
Latex on one or both sides	Reinforcement, non-skid	Reinforced low grade pad felts; non-skid typewriter pads
Rubber and starch sizing	Stiff reinforcement	Window channels



effectively seals itself, as well as the tightened joint. These resilient felts adhere to most surfaces including metal, glass, wood and ceramics; once applied, they remain soft and are not adversely affected by heat, pressure or the elements.

Of the many all-wool pressure sensitive felts available, the following types are in common use. First there is a general-purpose felt with pressure-sensitive adhesive on one side and Holland-cloth backing. This material is non-toxic, non-irritating and non-corrosive to all types of metals. It is high grade felt impregnated with a synthetic, rubber-like adhesive containing inert mineral fillers that retain full adhesive characteristics throughout the temperature range from —40 to 160 Fahrenheit.

The second type of adhesive-impregnated felt is designed for greater durability and easier application. The adhesive is unbacked, permitting the felt to be applied as soon as it is unrolled. This type is unaffected by citrus juices, alkaline cleaners, detergents, soaps and saline solutions, is non-hardening and will not wick. It effectively prevents seepage and corrosion, and also retards electrolysis when used between dissimilar metals.

A third type is designed for special service requirements. This is a moisture- and fungus-resistant, impregnated, all-wool felt coated on one side with a duo-purpose adhesive. It is suitable for either temporary or permanent installations and has no backing. The fungus resistant agent used is copper-8-quinolinolate, while the impregnant is a non-drying, non-corrosive chromate compound having a minimum softening temperature of 165 F. When reactivated with naphtha, adhesive forms a permanent bond.

Other types available include flame-, oil- and mildew-resistant, impregnated felts that conform to rigid government, naval and military specifications. These types will not deteriorate when exposed to salt water or lube oils.

Aside from their inherent advantages as materials, impregnated adhesive-backed felts have important use advantages. They are easy to cut, will not fray and can readily be applied to curved, overhead or vertical surfaces.

ASPHALT AND OTHER IMPREGNATIONS. Asphalt impregnations of 10 to 20 percent produce a treated felt well suited for weather sealing applications. It is used by the automobile industry for sealing parts, such as cowls, and for reducing squeaks.

For lubrication purposes, graphite impregnated felt is a good material for oil seals, washers, and anti-friction lubricating pads. In addition, the graphited felt is particularly valuable in the filtering of explosive materials. This is because the graphite resists the generation of static electricity. Since the felt is grounded, no static charge can be built up from friction created by the filtered substance passing through the felt.

For waterproof sealing, lubrication and packing applications, different kinds of felts are impregnated with paraffin or petrolatum. These are used for float valve plunger washers, needle lubricating pads in the textile industry, and marine stuffing box washers.

The life of felts subject to severe working conditions can be materially increased by use of resin impregnations. In cases where felts must withstand abrasive wear and frictional heat, resin impregnations increase the life of the material by 150 percent.

Hycar, natural rubber or neoprene impregnated felts are particularly useful for packing, sealing and gasketing purposes. Because of the controlled ratio of felt fiber to latex impregnant, such treated felts afford the double protection of positive sealing and self-lubrication for packing washers used in heavy-duty bearing seals. Selection of the proper latex impregnant depends on the nature of the liquid to which the seal is to be subjected. Hycar felts are recommended for service with gasoline or organic fluids; rubberized felts for hydraulic fluids, corrosive liquids or gases; and neoprene felts for mineral oils and greases. Typical uses of latex felts include fuel pump packing washers, mechanical seals for corrosive liquids, oil wipers, shock absorber packing and bearing seals.

SIZING IMPREGNATIONS. Special sizing treatments are available for practically every type of roll felt made and afford a wide range of industrial uses for such felts. This stiffening treatment, which consists of either a starch base, synthetic or natural resin emulsion impregnant, is used to facilitate the handling of cut parts in assembly, for support of a cut part with a thin wall, or to permit clean cutting with no fuzzy edges. The treatment has little or no effect on the ability of felt to absorb oil and is non-corrosive. It does, however, prevent distortion or stretching of cut parts before installation.

Resin treatments are also used to induce electrostatic charges and enhance the filtering ability of felts used for air conditioning and dust filtration problems. Preplugging of wool felt to a predetermined degree with solvent solutions of resins or resinous materials produces an electrostatic or physical attraction to the felt of minute dust particles in the sub-micron range. This device has made it possible to design a highly efficient respirator that protects industrial workers against all types of contaminating dusts in air. The filter also guards against: (1) Light organic fumes, vapors and gases; (2) acid gases, fumes and mists; (3) combined acid and organic gases; (4) low concentrations of ammonia; and (5) metal fumes found in welding, smelting and refining operations.

PROOFINGS. In the field of treatment impregnations, it is important not to overlook various proofing treatments that make felt resistant to flame, mildew, fungi, moths and water.

In flameproofing the inherently slow-burning wool fibers of felt, the treatment must effectively deal with two types of combustion that may occur either simultaneously or independently. The first type is combustion with flaming in which the volatile flammable gases of thermal decomposition unite with oxygen to produce flame. The second is flameless combustion, in which oxygen vigorously combines with the fibers to produce glowing. Treatments that comply with rigid government specifications (AN-S-32) have been devised that not only render felt difficult—if not impossible—to ignite, but cause it to feed flame so inefficiently that it is spontaneously extinguished when the flame is removed. The flameproofing treatment has no measurable effect on appearance, properties or serviceability of felt.

For military and other uses, it is important to use treatments that protect felt against attack by fungi or bacteria. This is true of felts that contain sizings or stiffening agents, or where the basic wool fiber is blended with other fibers, such as cotton, which

are more susceptible to bacterial and fungus attack than wool alone. Tests have shown that mold growth can be effectively overcome if the felt is treated with dihydroxydichlorodiphenylmethane or salicylianilide.

Studies at the U. S. Army's Frankford Arsenal reveal that 100 percent wool felt gaskets treated with dihydroxydichlorodiphenylmethane do not promote growth of fungi when exposed to various species of fungi. Although this chemical affords a good measure of safety for all felt gaskets, its effectiveness decreases as the amount of cotton used in the felt increases and the amount of wool fiber used decreases.

Plain wool felt is, of course, subject to attack by moths and carpet beetles. The industry has developed successful treatments based on phenol compounds that fully protect against moths. These compounds do not impair the texture, tensile strength, appearance or thermal transmission of the felt. They are non-toxic, impart no odor, and felts so treated withstand several wettings without losing their protective characteristics.

For applications where water-repellency is important, felt is impregnated with a water-resistant, flexible, noncorrosive material. This causes the felt to shed water but does not make it impervious. The compound is nonleaching and unaffected by sunlight. Felts so treated find their greatest use as weather stripping, cowl stripping, and as gasketing for box closures. Where some stiffness together with water resistance is required, asphalt-impregnated felts are available.

In contrast, there are times when an affinity for water is desirable. While felt is by nature absorbent, its initial wetting-out properties can be substantially increased by special treatment. Since the object is to increase wettability, a compound is built into the felt, thereby reducing the surface tension of liquids into which the material may later be placed.

LAMINATIONS. In addition to being impregnated so that they serve special purposes, felts are also laminated in various ways and with different materials. By so doing, felters build up resistance to the deteriorating action of liquids and solvents. Special felts of this type are used by the automotive, aircraft, machinery, appliance and other industries for rigid packing and gasketing applications.

In general, these laminated felt parts appear to be superior to cork, rubber, asbestos and paper materials, because of their physical properties and resistance to various types of liquids.

By laminating felt with rubber or synthetic rubber latex, it is possible to fabricate seals of smaller dimensions than similar parts made of plain or untreated felts. The laminated construction imparts greater inherent strength and stability to the felt and allows for closer working tolerances. The rubber or synthetic barrier acts as a positive dam in a felt seal, preventing the entrance of water, dirt and foreign matter from the outside, and prohibiting the leakage of lubricant from within. Modifications of this construction, utilizing two or more laminations, have been developed to meet progressively more difficult mechanical sealing applications.

Laminated felt is manufactured in sheets 36 by 48 in. and in thicknesses ranging from $\frac{1}{32}$ to $\frac{1}{2}$ in. to a standard tolerance of ± 0.010 inch. Dimensional tolerances of cut parts are maintained within 0.005 inch.

Where shock absorber packings are used in conjunction with castor oil or glycerine hydraulic fluids, natural rubber laminations are preferable. Neoprene is superior with mineral oils, and Hycar laminations are best suited where high octane gasolines or aromatic hydrocarbons are encountered. Hycar also is preferable to neoprene in low-viscosity oil applications where no swelling is permissible and all parts are precision fitted. In sealing against corrosive agents—such as chlorine—natural rubber and Buna S appear to function best.

Felt is also laminated with aluminum and lead foil for special purposes. Felt laminated with aluminum foil is used for reflectant and acoustical purposes and for thermal insulating blankets; felt laminated with lead foil is a good gasketing material for vapor seals in cold-line pipe installations.

Selection of the appropriate type of laminated felt is governed largely by the properties of the laminations as listed in Table II. In this table, laminates of Hycar, neoprene, Buna S and rubber are shown in relation to their performance characteristics.

COATINGS AND MISCELLANEOUS TREATMENTS. Felts of various grades and colors are treated with special water- and oil-proof coatings, as well as other formulations, to meet specific end uses. Sometimes the function of a coating is to impart gripping action, as in felts used for non-skidding typewriter pads which are surfaced with latex rubber. Or, polyvinyl acetate coatings are used as an adhesive-type backing for automotive channel felts where the material must adhere to structural parts of the car.

Table II—Properties of Felt Laminated With Various Materials

Property	Hycar	Neoprene	Buna-S	Rubber
Hardness, Shore A	90	90	90	90
Specific Gravity, percent	118	118	118	118
Min Tensile Strength, psi	2,000	2,000	2,000	2,000
Max Compressive Set, percent (ASTM D395, B)	40	40	50	35
Wear resistance	Excellent	Good	Excellent	Excellent
Temperature Range, F				
Operative	−50 to 300	−60 to 300	−20 to 300	−70 to 300
Dry	−40 to 200	−50 to 200	−10 to 200	−60 to 200
Degree of resistance to:				
Water	Avg	Avg	Avg	Low
Mineral oils and greases	High	High	Low	Low
Hydraulic fluids	Avg	Avg	Avg	Low
Gasoline	High	Avg	Low	Low
Organic fluids	High	Low	Low	Low
Corrosive liquids and gases	Low	Low	Avg	High

Whole Number Solutions of Indeterminate Equations for Gearing

SIGMUND RAPPAPORT
Project Supervisor
Ford Instrument Co.*

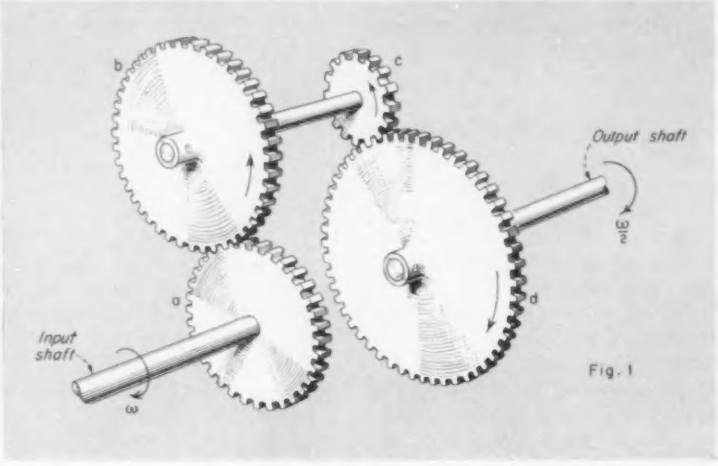


Fig. 1

INDETERMINATE EQUATIONS, those that have an infinite number of solutions, frequently arise in gearing problems, especially planetary gearing. But only a few of the many solutions, or perhaps none at all, will satisfy the practical conditions of a given problem. For example, the solutions may have to be positive integers, as where the unknowns in the equations refer to the number of gear teeth; or the solutions may have to be minimal values, or lie between given limits. In problems that are not too complicated, a trial-and-error method is often successful, although one can never be sure that the solutions found are the best ones, or even whether or not other solutions exist.

Assume the following equation were given:

$$3x + 5y - 172 = 0$$

In addition, x and y are to be positive integers, and their difference to be a minimum. The trial-and-error method might proceed like this:

To satisfy the condition that the difference between x and y is minimal, a first approach could be: $x = y$.

Substituting this condition into the given equation:

$$3x + 5x - 172 = 0,$$

Therefore

$x = 21.5$, which is not an integer.

A second attempt might be

$$x = 20.$$

Then,

$y = 22.4$, which is still not an integer.

After repeated trials the equation may be solved for $x = 24$, $y = 20$; but it is still uncertain as to whether or not more suitable solutions exist.

A method developed almost 2,000 years ago, but little known among engineers, solves this kind of problem. It is generally referred to as "Diophantine Equations". Applied to the preceding example, it proceeds as follows: Given,

$$3x + 5y - 172 = 0.$$

Therefore,

$$x = \frac{172 - 5y}{3}$$

$$x = 57 + 1/3 - y - \frac{2y}{3}$$

Or $$x = 57 - y + \frac{1 - 2y}{3} \qquad (2)$$

which is obtained by first separating and then gathering the integral and the fractional terms.

It is required that x and y be integers, hence $\frac{1-2y}{3}$ must be an integer. Call this integer u. Then:

$$\frac{1 - 2y}{3} = u; \qquad (2a)$$

Solving equation (2a) for y and again separating integral and fractional terms:

$$y = -u - \frac{u}{2} + \frac{1}{2}$$

$$y = -u + \frac{-u + 1}{2} \qquad (3)$$

Since by definition both y and u are integers, $\frac{-u+1}{2}$ must be an integer, and can be designated by v. Then,

$$v = -\frac{u + 1}{2} \text{ or} \qquad (4)$$

$$u = 1 - 2v$$

* Division of The Sperry Corp.

This eliminates all fractional terms. Substituting Eq (4) into Eq (3)

$$y = 3v - 1. \quad (5)$$

Similarly, from Eqs (2), (2a), (4) and (5)

$$x = 59 - 5v \quad (6)$$

Therefore, x and y will be integers for all integral values of v. For example, if $v = 1$, $x = 54$, and $y = 2$.

Considering the other initial condition that the difference between x and y be as small as possible, Eq (5) is set equal to Eq (6). Hence,

$$59 - 5v = 3v - 1$$

or

$$8v = 60:$$

The values of v that satisfy this condition as closely as possible are $v = 7$ and $v = 8$. Substituting $v = 7$ in Eqs (5) and (6), $x = 24$ and $y = 20$ (the solution found previously by trial-and-error). Similarly, for $v = 8$, $x = 19$, and $y = 23$. Thus, the analyzer has his choice of two possible solutions. Example 2: Given,

$$23x - 59y - 88 = 0.$$

Find the solution giving the smallest positive integers for x and y. The procedure follows that of the first example.

$$x - 2y - \frac{13y}{23} - 3 - \frac{19}{23} = 0$$

$$x - 2y - 3 - \frac{13y + 19}{23} = 0 \quad (7)$$

Setting the last term on the right hand side equal to integer u,

$$13y + 19 - 23u = 0, \text{ or}$$

$$y + 1 + \frac{6}{13} - u - \frac{10u}{13} = 0, \text{ and}$$

$$y + 1 - u + \frac{6 - 10u}{13} = 0$$

Setting the last term on the left hand side equal to integer v,

$$6 - 10u - 13v = 0, \text{ or}$$

$$-u - v + \frac{6 - 3v}{10} = 0 \quad (8)$$

Again, equating the last term on the left hand side to integer w,

$$-3v + 6 - 10w = 0$$

$$v - 2 + 3w + \frac{w}{3} = 0 \quad (9)$$

If the last term on left hand side is replaced by integer p,

$$w = 3p \quad (10)$$

Substituting Eq (10) in Eq (9):

$$v = -10p + 2 \quad (11)$$

Similarly,

$$u = 13p - 2 \text{ and} \quad (12)$$

$$y = 23p - 5 \quad (13)$$

Finally, from Eqs (7), (12) and (13)

$$x = 59p - 9$$

To make x and y the smallest positive integers, p is taken as unity and the solution is $x = 50$, $y = 18$.

Non-Linear Equations

Diophantine equations are applicable to linear equations only. However, by modifying the method, some classes of non-linear equations can be handled.

Suppose the gearing shown in the Fig. 1 must have an overall ratio

$$\frac{a}{b} \cdot \frac{c}{d}$$

of 1:2, where a, b, c and d designate the numbers of teeth. Input shaft and output shaft are co-linear, hence the center distance between a and b equals the center distance between c and d. Further, this center distance is given such that the sum of a and b as well as the sum of c and d is 70 teeth. Then,

$$\left(\frac{a}{b}\right)\left(\frac{c}{d}\right) = 1/2 \quad (14)$$

$$a + b = 70 \quad (15)$$

$$c + d = 70 \quad (16)$$

These three equations with four unknowns can be reduced to one equation with two unknowns. This, and the stipulation that all values be whole numbers, is a characteristic Diophantine condition. Substituting Eqs (15) and (16) in Eq (14)

$$\left(\frac{a}{70 - a}\right)\left(\frac{c}{70 - c}\right) = 1/2$$

Solving for a in terms of c,

$$a = (4900 - 70c) / (70 + c), \text{ or}$$

$$a = 70 - \frac{140c}{70 + c} = 70 - u, \quad (17)$$

where

$$\frac{140c}{70 + c}$$

has been set equal to integer u. Therefore,

$$140c = 70u + uc$$

$$c = \frac{70u}{140 - u}$$

$$c = -70 + v \quad (18)$$

where integer $v = \dfrac{70(140)}{140 - u}$

Therefore,

$$70\,(140) = 140\,v - u\,v$$

$$uv = 140\,(v - 70)$$

Solving for u,

$$u = \frac{140\,(v - 70)}{v} = 140 - \frac{70\,(140)}{v}$$

Or

$$u = 140 - w \quad (19)$$

where integer $w = \dfrac{70\,(140)}{v}$;

Then,

$$v = \frac{70\,(140)}{w} \quad (20)$$

Substituting Eq (20) in Eq (18),

$$c = -70 + \frac{70\,(140)}{w} \quad (21)$$

Similarly, from Eqs (17) and (19),

$$a = 70 - 140 + w = w - 70 \quad (22)$$

Also, $b = 70 - a = 140 - w$ (23)

Finally, $d = 70\left(2 - \dfrac{140}{w}\right)$ (24)

Since a and b must be positive integers; from Eqs (22) and (23), w must satisfy the condition:

$$70 < w < 140$$

Also, it follows from Eq (20) that 70 (140) must be divisible by w. The prime factors of 70 (140) are 2 x 2 x 2 x 5 x 5 x 7 x 7. Consequently, w consists of some of these prime factors, and lies between 70 and 140. Only 7 x 7 x 2 and 5 x 5 x 2 x 2 fulfill these conditions; therefore, $w_1 = 98$, $w_2 = 100$. Substituting these values in Eqs (21), (22), (23) and (24),

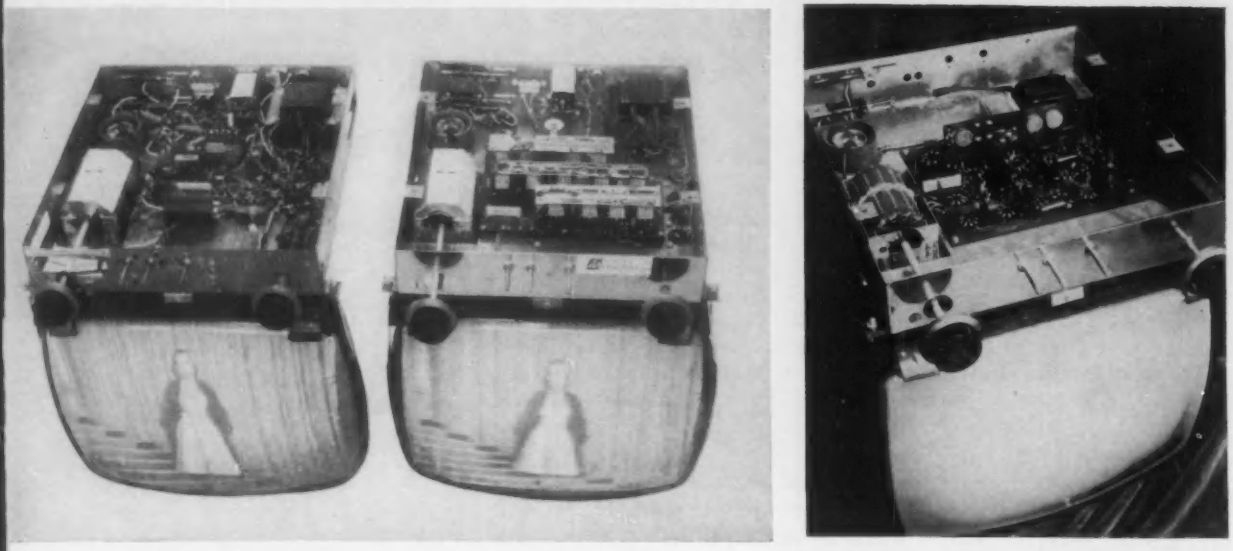
$a_1 = 28$, $b_1 = 42$, $c_1 = 30$, $d_1 = 40$,

and

$a_2 = 30$, $b_2 = 40$, $c_2 = 28$, $d_2 = 42$

Thus, as it may have been expected, gears a and b can be interchanged with c and d, the other pair.

TECHNICAL NEWS



A COMPARISON OF THE standard construction (left), with the modular project Tinkertoy components (center), and the latest step involving the "reliaplates", or the depth factor concept in printed circuitry. The result is increased circuit simplicity.

NOW—3D IN PRINTED CIRCUITS

SANDERS ASSOCIATES, specialists in electronic design, who two months ago (*Product Engineering*, March 1954, p. 213) came up with a TV receiver based on the project Tinkertoy modular design technique, have gone a step further and developed a receiver that is composed entirely of printed circuits. Key to the new receiver is a "third dimension" or rather "depth factor", which has been added to the concept of printed circuitry to permit the crossing of many wires in a circuit without making a connection. Heretofore this has been impossible in printed circuitry on a flat, single-sided sheet. Lack of this facility, according to Sanders, has prevented the complete mechanized production possible with parts containing printed circuits.

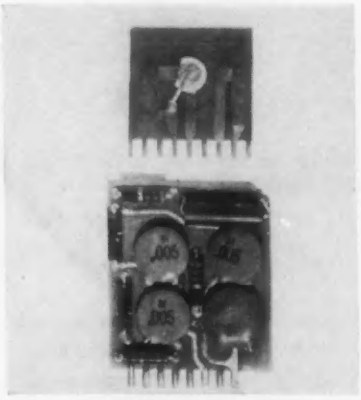
The new "depth" factor has been introduced through the addition of small panels, or "reliaplates" as they are called, about one inch square. These panels, containing printed circuits themselves, have small comb-like teeth, and are plugged into a row of holes on the master etched circuit. Connection of these panels (19 for a 21 in. television receiver) is made in one operation by dip soldering.

The panels can use either tape or conventional resistors, and ceramic or conventional capacitors, which are adaptable to high volume production, besides cutting size and weight.

The circuitry for a large number of reliaplates can be printed on a standard size sheet of copper clad plastic or laminate. As an example: a 3 ft. square sheet can be cut to produce 1,000 reliaplates which would give enough material for over 50 television sets. After printing the circuitry on the sheet, the required components can be added at high speed.

Project Tinkertoy also makes use of a third dimension in circuit construction by stacking of 5 or 6 wafers (see above, center).

The way Sanders sees it, while the cost involved in changing to modular design for volume production is prohibitive, the question posed to industry is: Will it be worth it? Some figures offered by Sanders are: $5 to $10 saving at the manufacturers level for a 21 in. television set; elimination of hand soldering operations and handling of many individual components; low cost and ease of repair; and, a coming factor—color TV with twice the amount of circuitry of a black and white set, can be constructed in the same size chassis.



THE NEW SANDERS ASSOCIATES "reliaplates" with standard components, bottom, and the project Tinkertoy components, top. The result is a more effective use of the printed circuit technique for electronic design.

TRANSISTORS FOR COMMERCIAL MARKETS

THAT THE GERMANIUM TRANSISTOR—the tiny replacement for vacuum tubes—is no longer a laboratory phenomena, is proved today by the nearly 200,000 users of hearing aids—proof that the transistor will soon be making its impression on the $5 billion electronic market. This, in essence, is the statement made by N. B. Krim, Vice-President of Raytheon Mfg. Co.

Heretofore, the use of transistors has been hampered by two factors. First, and probably foremost, was reliability. This, Raytheon feels, is a thing of the past. Field tests on hundreds of thousands of transistors showed failures in actual service are now running at about one percent per year. Failure rates on units produced during the past six months are even less. In fact, their present reliability is expected to approach that of high quality subminiature tubes for hearing aid service—about one-half percent.

The other drawback was production; both rate of production and cost were too high. This, too, has been overcome. Current designs are being mass-produced at rates of thousands per day with semi-skilled workers.

Some of the products now in limited commercial production using Raytheon's transistors are:

(1) A low noise, high intelligibility microphone, to replace carbon microphones in aircraft, mobile intercommunication equipment, and radio systems.

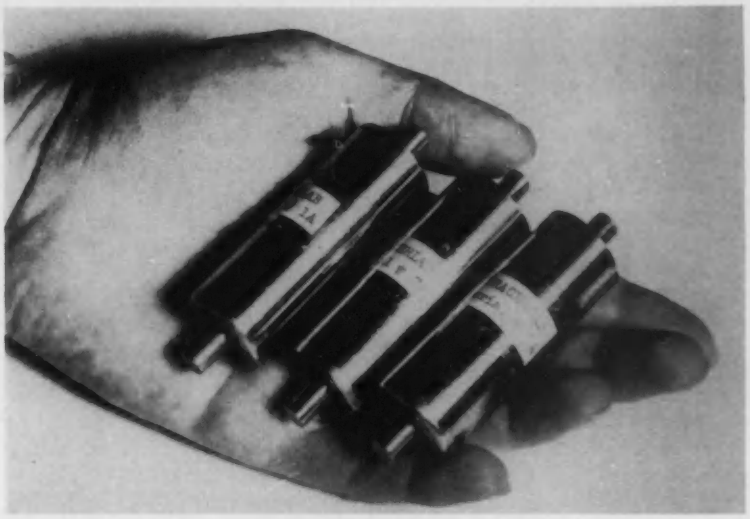
(2) Portable audio frequency oscillator for ease in making tests in telephone, broadcasting, and similar fields where a bulky inconvenient oscillator is now required. Uses small hearing aid batteries, yet provides a long life and convenience.

(3) Small oscillator, crystal controlled, for use as secondary frequency standard in a wide variety of applications. Single, small, self contained batteries will operate the oscillator for about two years continuously, so no switch or other controls are used.

(4) A flashlight battery powered, high-voltage supply in an unusually small package for operating portable radio-activity measuring instruments and in other applications. This device converts the voltage from a couple of ordinary flashlight batteries to as much as two thousand volts. The transistor replaces the more convenient but less efficient vibrator. Finished device weighs only $7\frac{1}{2}$ oz, and is in a package only $2\frac{3}{4}$ in. x $1\frac{3}{4}$ in. x $1\frac{7}{8}$ inches.

(5) Transistor pre-amplifier and magnetic amplifier in combination for controlling motors and other industrial devices rated up to 500 watts.

(6) Sound pick-up for amplifier of film projector. Transistor gives full sound-range amplification.



TRACERLAB'S new atomic battery. Possible uses are in hearing aids, survey instruments for measuring radiation, electrical fuses or trigger alarm devices, and instruments requiring a long life, low level power supply.

ATOMIC BATTERIES: ONE MORE

TO A SMALL BUT GROWING LIST in the field of atomic battery development has been added a third name. Tracerlab, Inc. of Boston, Mass., working under a Signal Corps contract has just announced their new battery which uses radioactive tritium, an element of the hydrogen bomb, as the source of initial power. Two other companies in this field, (*Product Engineering*, March 1954, p 210) are Ohmart Corp. with their gas cell, and RCA with their crystal battery.

According to Mr. Alexander Thomas, nuclear physicist at Tracerlab, "Unlike other proposed nuclear batteries, there is practically no danger associated with the use of the tritium isotope, because the beta rays it gives off are so weak they can be completely absorbed by a piece of newspaper."

The construction and principle of the battery is quite simple, and is similar to that developed by Ohmart. A cylinder smaller than a conventional flashlight battery is filled with the radioactive medium which surrounds pairs of metal plates having different surface electrical characteristics. These characteristics will attract the radio-activated current, which, upon reaching the plates, will deliver a voltage in proportion to the difference in electrical characteristics of the plates.

The new batteries developed experimentally by Tracerlab can give up to 400 volts at very low current. The output depends upon the amount of tritium used in the batteries, ranging in cost from $1 to $100.00 at present prices, and will produce 0.01 to 1.0 microwatts.

The batteries will have an optimum life of about 18 years, but can be increased to 30 years, depending on the design. During this time there would be constant voltage, although the current would decline at a known rate.

EXPANSION—PLASTICS INDUSTRY THEME

DIRECTLY RELATED TO the consistent expansion of the plastics industry are two basic factors—introduction of "new" materials; and volume use of these materials by such prime markets as electronic, automotive and aircraft. This second factor will receive considerable emphasis in Cleveland during the Sixth National Plastics Exposition, June 7-10, at a technical conference devoted to the "Expanding Application of Plastics In Industry." But uses don't expand until new materials have been thoroughly evaluated and processes suitably developed. The new advances in materials and techniques to be discussed are:

Phenolics . . . Significant trend is the increasing use of rubber modified compounds (Durez, General Electric) which permit thinner wall sections, resist cracking during metal insert operations such as press fitting, and permit more latitude in mold design.

Major reason for these advantages is that rubber phenolics combine low modulus, 0.4 x 10^6, with Izod impact strength as high as 2.30 ft-lb, depending upon incorporated filler. Other active developments in phenolic materials: reinforced glass fiber compounds with minimum impact strength of 12 ft-lb for heavy duty insulators, brackets, spring holders; vinyl butyral modified binder for clutch plates, sanding wheels; low-pressure, 50-200 psi, laminating resins which in reinforced plastic construction, develop a flexural strength comparable to standard aircraft metals at service temperatures as high as 500 F.

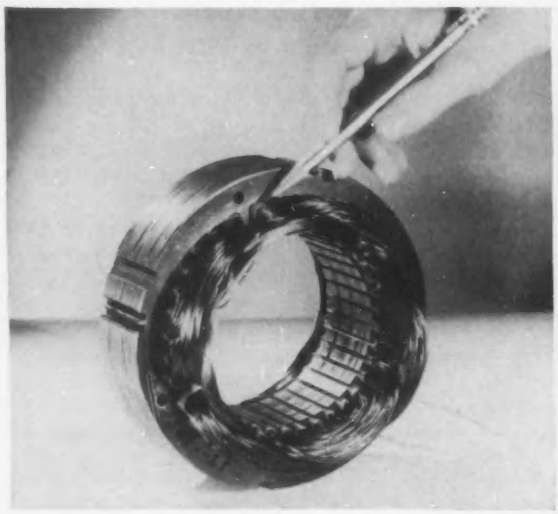
Styrenes . . . During 1953, rubber modified types accounted for more than a third of total industry sales of styrene molding compounds. According to E. V. Hellyar, Monsanto Chemical Co., the consumption of these materials will approach 300,000,000 lb in 1960.

While injection molded products are still the primary factor in this usage, vacuum forming offers many new possibilities. Although vacuum forming sheet may be more expensive than injection molding, equipment and tooling requirements are less expensive, and dies can be prepared readily, permitting a manufacturer to cut down considerably on his development time. Other sheet materials processed by vacuum forming: acrylics, vinyls, polyethylene, and cellulosics.

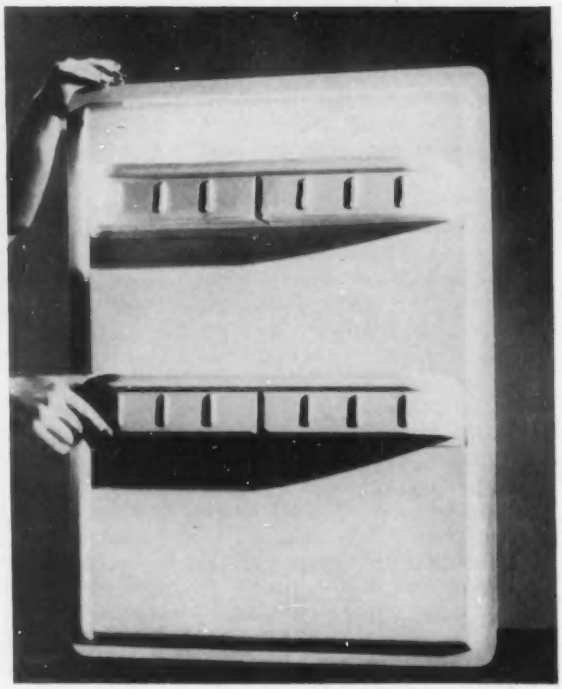
Oak Ridge National Laboratory, operated by Union Carbide has prepared a radioactive polystyrene containing the carbon-14 radioisotope. The radioactive plastic can be prepared for laboratories as a soft-beta counting standard. Routine checking of radioactivity over a long period of time requires frequent standardization against known standard sources of radioactivity. This standard should be chemically and physically stable for long periods of time, be resistant to flaking or corroding on constant handling, and be of a radioisotope that has a long half life.

Cellulosics . . . Cellulose acetate and cellulose acetate butyrate have been widely used in vacuum forming. But one of cellulose acetate butyrate's (Tennessee Eastman) important uses has also been in the plastic pipe field where its resistance to corrosion, light weight, and ease of installation have initiated its use in oil, gas, and corrosive water line service. For strong acid, alkaline, and organic solvent exposure, it is not generally recommended.

Now under way at Battelle Memo-



(ABOVE) Electric motor stator designed by General Electric is insulated with Mylar polyester film. Used for thin slot liners, wedges and for phase insulation, the film replaces heavier cellulose insulation.



(RIGHT) First production model of a vacuum molded refrigerator inner door panel as produced by the L. A. Darling Company.

rial Institute is an engineering research program, sponsored by plastic pipe extruders and interested material suppliers, to set up test methods on such factors as bursting strengths, long-range serviceability of plastic pipe under static pressure, and its behavior under dynamic loading. This project will take approximately two years. Other plastic pipe materials: modified styrenes and copolymers, polyester reinforced plastic, vinyls, fluorocarbon plastic and . . .

Polyethylene . . . The progress of polyethylene commercially introduced in this country only ten years ago, has been more rapid than any other plastic material. It is expected to be the first plastic to attain a yearly production of a billion pounds.

Recent trends in polyethylene . . .
• Increased use of chlorosulfonated polyethylene (E. I. duPont de Nemours, Inc.) which approaches elastomers in behavior. It is unlike conventional polyethylene which is semi-crystalline in structure, and possesses mechanical properties analogous to non-ferrous metals. With excellent resistance to ozone, heat and abrasion, good flex-life, and compatibility with other rubbers, it is being used or evaluated for aircraft gaskets, tires, wire insulation and weather stripping.
• Introduction of irradiated polyethylene (General Electric Co.), which, differing from conventional polyethylene, does not melt or flow under light load at temperatures as high as 350 F, and exhibits resistance to stress-cracking after exposure to a broad range of chemicals. Irradiated polyethylene is presently available in film form only. Its tensile strength decreases with increasing temperature until 230 F is reached, at which point the tensile levels off at 100-200 psi. It retains this residual strength to at least 400 F. Major use is expected in miniaturized electrical equipment with consequent improved operating characteristics.
• Introduction of cellular polyethylene (Bakelite Co.), principally for wire coating use where lower weight and lower electrical attenuation and line losses are required, particularly at high frequencies. The material has half the specific gravity of the original polymer and a reduced dielectric constant.

Fluorocarbons . . . Developments in these plastics (Bakelite Co., E. I. duPont de Nemours, Inc., M. W. Kellogg, Firestone Plastics Co.) are twofold: processing improvement, and material modification. Recently reported is an improved grooved roll calender and sintering method for heavy coating of wire with Teflon, and ram extrusion of the polymer, which should permit fabrication of shapes too difficult up to now.

In addition, a new Kel-F elastomer has just been developed that possesses good electrical properties over a temperature range of —15 F to 400 F.

Still in the evaluation stage is the loading of fluorocarbons with aluminum, graphite and other fillers.

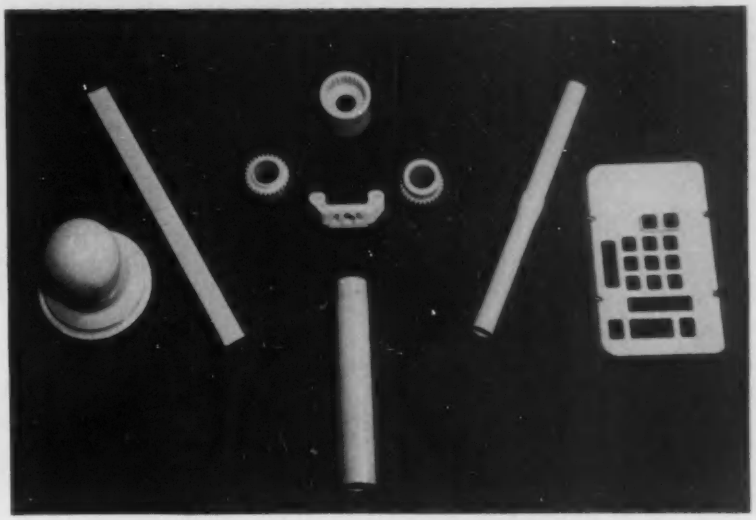
Silicones . . . Also in the high-temperature application field, silicones are undergoing constant product improvement. Recently developed has been a silicone rubber series (General Electric Co.) possessing a tear strength of 190 psi, two to three times higher than others presently available and a tensile strength approaching 1,000 psi. These materials have low compression set and their flexibility is maintained between —55 and 550 F. New materials good for bonding organic materials with inorganics are the vinyl silicones (Linde). Glass fibers joined with plastics are treated with vinyl silicones to make moisture-proof transparent laminates with 74,000 psi wet strength.

Copolymers of silicone and oil-modified phenolic resins (Dow Corning Corp.) constitute an entirely new class of protective coating vehicles. They air-dry to a hard film in 16 hr or less, exhibit excellent color retention after 1,000 hr accelerated weathering exposure and possess water and chemical resistance superior to comparable silicone alkyds.

Other important developments . . .

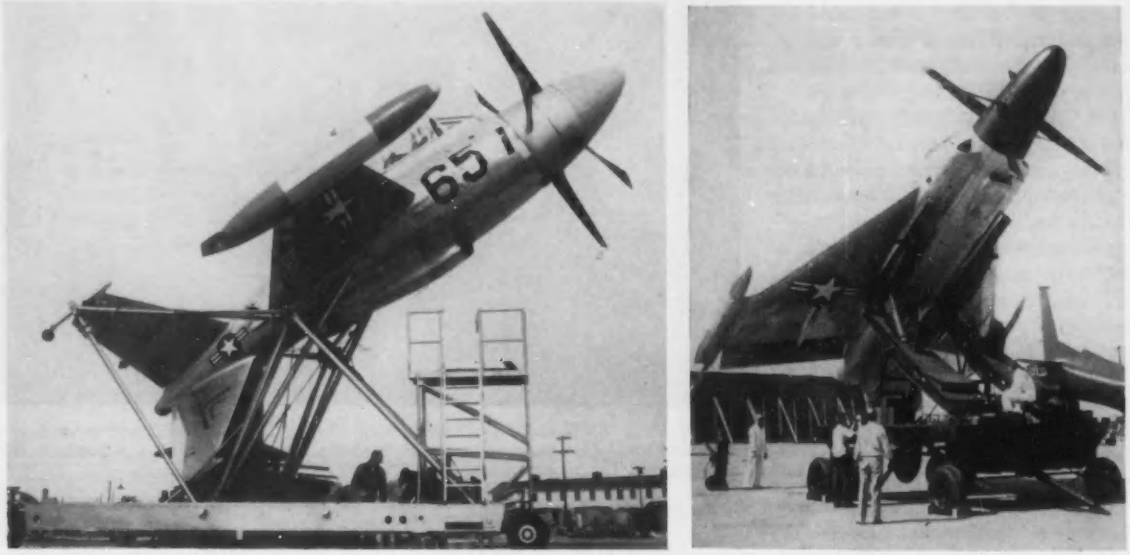
Isocyanate elastomers, first produced in Germany, are regarded in this country as materials of high tensile strength and abrasion-and-oxidation-resistance. Industrial belting and gears are promising applications.

In the field of reinforced plastics, stress is being placed on the accumulation of basic chemical and mechanical engineering data. The Reinforced Plastic Division of SPI is sponsoring standardization in all fields of use and sound design data will be increasingly available. Epoxide resins are under considerable investigation as casting, potting, coating, laminating and adhesive resins. Principal among the attributes of these resins are their fast-setting and low-shrinkage properties. Recently a new class of flexible thermosets has been developed by the copolymerization of epoxide resins and polysulfide liquid rubbers (Thiokol Chemical Corp.). The advantages gained from the polysulfides are permanent flexibility, high impact resistance, good aging, and, oil, water, and chemical resistance.

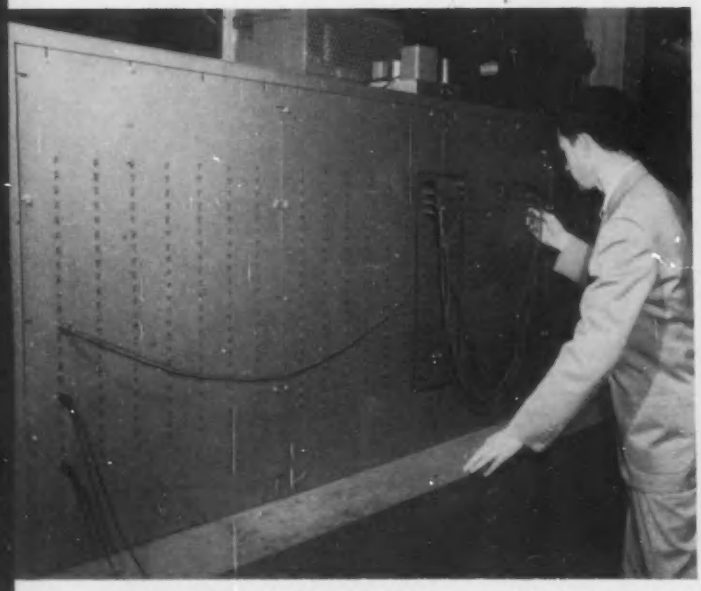


JUST DEVELOPED by Borg-Warner Corp., a high impact thermoplastic styrene-type resin with good heat resistant properties. Called Cycolac, some of its end products are shown above. The piping will take 200 lb per sq inch.

THE NEWS IN PICTURES

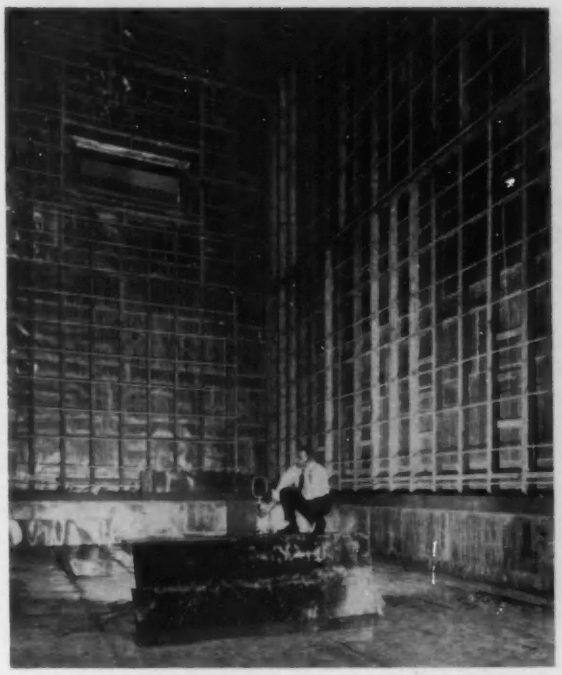


SOMETHING NEW IN FIGHTER PLANES—Lockheed's XFV-1 (left) and Convair's XFY-1 (right). Shown above on their special ground handling carts, both planes are powered to take off straight up, level off to fight at very high speeds, hover like a humming bird and land on a dime by backing straight down. With this plane almost all Navy ships would be able to carry their own aerial protection. A unique feature is the tilting pilot's seat to keep the pilot in a semi-upright position while the ship is vertical.



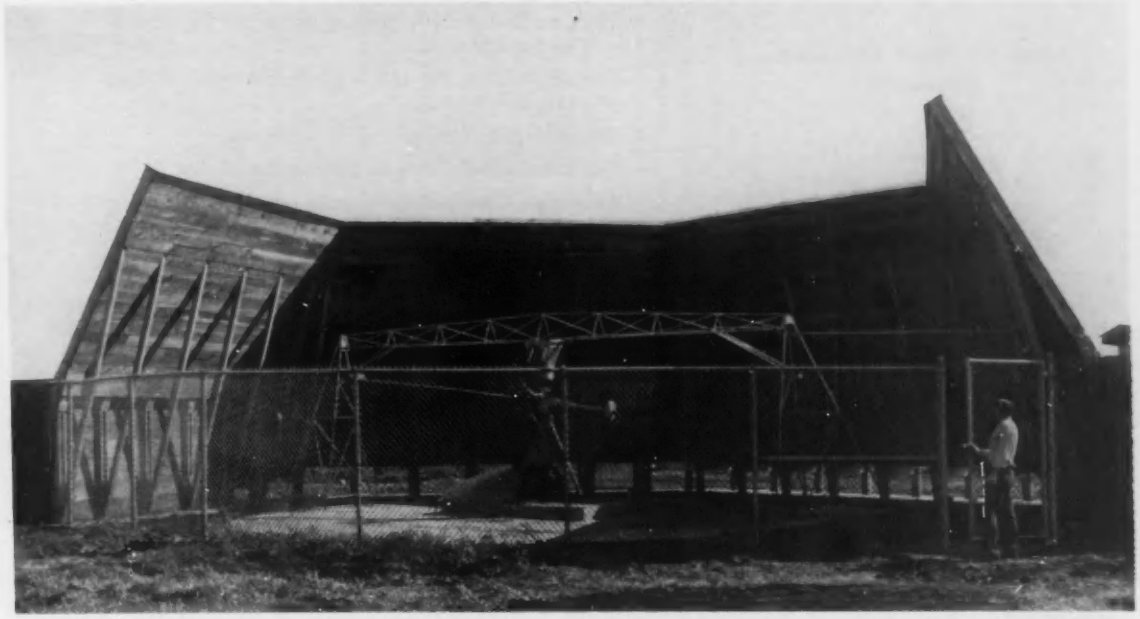
ELECTRONIC GUIDED MISSILE controls are being flown at high altitudes without ever leaving the ground—on this new "missile mission" simulator developed by Northrop Aircraft. Systems can be installed in the test stand with all wiring intact. All components are accessible for manipulation and correction, and all control surface and throttle movements can be simulated. Here an engineer works at the terminal board connecting test jacks to various check points to determine the accuracy of any segment of the system.

A WAX MODEL of a cargo ship during tests in the deep-water basin of the David Taylor Model Basin. Replacing wood as the model material will permit savings, as the wax can be melted for reuse and hull shaping takes less time. English china clay is used as the mold to form the exterior hull contour. Hull models up to 31 ft in length and submarine models have been built with the new process. Carriage pulling hull model has top speed of 60 knots (69.1 mph).



AN ENGINEER at General Electric's transformer plant checks the effectiveness of the 20,900 pounds of copper that have been used to line a new sound test building. The chamber is 68 ft. long, 58 ft. wide, and 60 ft. high and will permit G-E to determine the amount of radio and TV interference created by transformers and other apparatus. Noise and vibration tests in the chamber will be accurate to ½ db. Tests for interference will be conducted in the radio and television range beginning at 550 kc; 100 to 1 attenuation at one megacycle is specified.

THIS KING SIZE titanium and silver diaphragm control valve has been designed by Minneapolis-Honeywell's Valve Div. for high pressure service of a highly corrosive fluid. The trim of the valve was machined from solid titanium. Under severe operating conditions it will last about 70 days before requiring replacement. The silver lining, or sleeve, 3/32 in. thick was inserted in the inlet bore to increase body life of the valve. To further offset the corrosion, which is 1/1000 inch per day, the bore was made ½ inch smaller than usual practice calls for.



VIEW OF HILLER HELICOPTERS' new sound muffler for their jet engine whirl test. The lower half of the wall is made of two wood walls with 3 ft. of dirt fill between. The upper section is a double wall with a fiberglass blanket between. It measures 18 ft. high and 40 ft. in diameter. Because of problems concerning air intake for jet engines, the barrier could not be completely enclosed.

SAVE MONEY

with

top quality, longer-lasting *Norgren* hose assemblies

30 TON PRESSURE SWAGES
permanent-type couplings to hose—assuring tight seal.

BURST CHAMBER TESTS
hose assemblies to destruction, using pressures up to 30,000 psi. Norgren Couplings are designed to withstand burst pressure of hose furnished.

Norgren Hose Assemblies available with permanent or re-usable couplings.

High, medium and low pressure assemblies for air and hydraulic service.

Sizes from ¼" to 1½" I.D. in permanent types; ¼" to 1" in re-usable types.

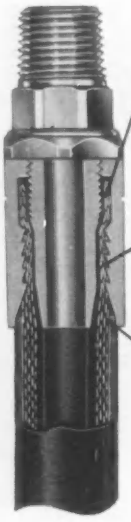
Pressures up to 4500 psi. (¼" 2-wire braid.)

1 and 2-wire braid hose; also 2-rayon braid hose, 3/16" to 1½"

Couplings: Combinations of male and male, male and union male, union male and union male, male and union female, union female and union female.

Also a complete line of couplings, stems and fittings.

HIGH PRESSURE REUSABLE COUPLING



LOCK POINT
Special design of coupling expands and locks hose into this chamber—assuring tight, non-slip fitting.

SEAL POINT
Tight seal and heavy wall eliminates loss of compression under extreme usage.

FLEX POINT
Special design relieves tension at flexing point—results in longer hose assembly life.

PIONEER AND LEADER IN OIL-FOG LUBRICATION FOR 26 YEARS

WRITE FOR CATALOG SHEETS

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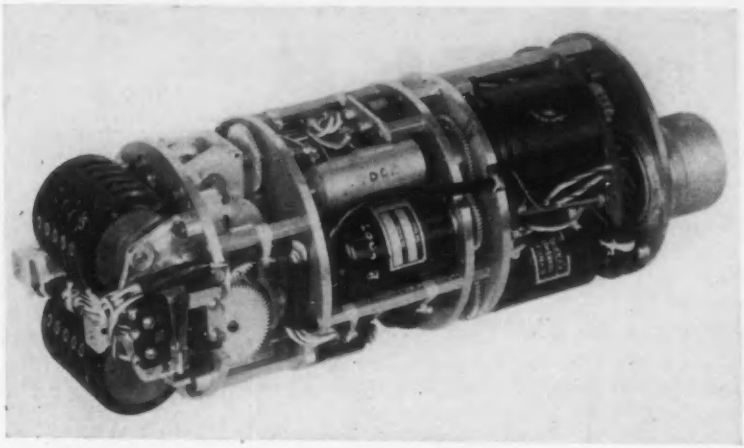
Valves • Filters • Regulators • Lubricators • Hose Assemblies

AIRCRAFT NAVIGATION GOES AUTOMATIC



THE INDICATOR is a panel-mounted unit about 8 in. long and 3 in. in diameter on which the present latitude and longitude of the plane is continuously shown. The case is hermetically sealed and filled with a nitrogen helium gas mixture. Two switches, one each a latitude and longitude slew motor are attached to the unit to permit setting of the latitude and longitude of the aircraft at the place of departure, or in flight.

WITH AN EYE TOWARDS FREEING PILOTS of most of their navigational problems, Ford Instrument Co. in conjunction with The Communication and Navigation Laboratory of The Wright Air Development Center has come up with a new aircraft instrument that automatically and continuously gives the pilot his latitude and longitude. Called the Computer Set, Latitude and Longitude, it operates solely from input data from instruments within the aircraft, and requires no help from radar, radio, or even visual observation.

The entire mechanism consists of four units—the indicator, computer control, computer, and amplifier—all of which are squeezed into a volume of less than $1\frac{1}{2}$ in. ft and weigh 45 pounds.

The indicator, at left, is a panel-

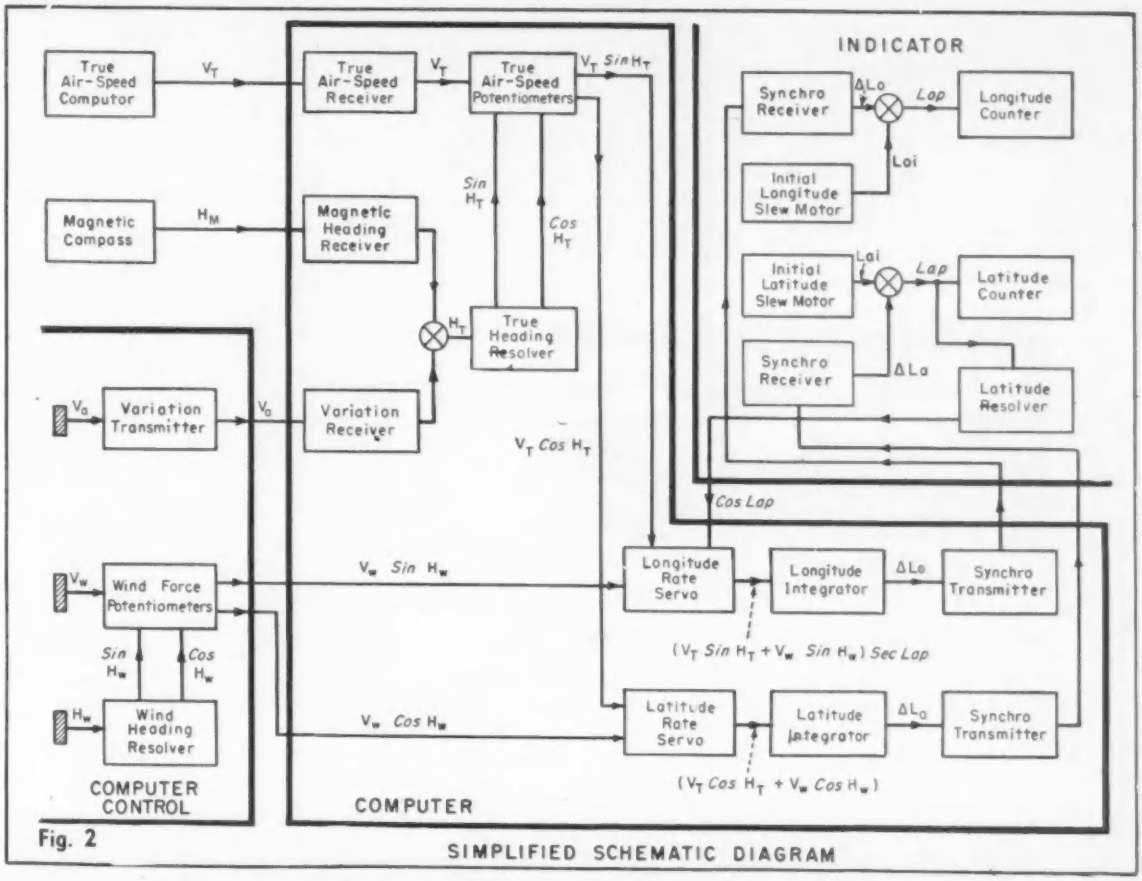


Fig. 2 SIMPLIFIED SCHEMATIC DIAGRAM

Seeing is Understanding

You'll see how the elimination of flanges and undercuts on the inner ring provides a *wider* contact area for the rollers.

This SKF Story Of Spherical Bearing Design Improvement

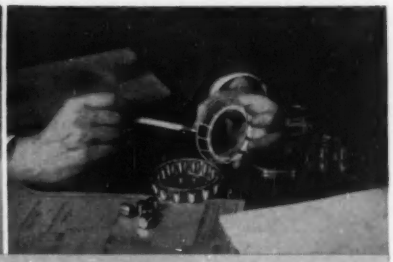
When SKF first announced that its *improved* (Type "C") Spherical Roller Bearing provides, size for size, up to 50% more capacity and 2 to 3½ times longer life than any other available design, most people asked:

"How was this done?"

Your SKF District Office has the answer, in the form of a clear, quick *visual* demonstration. Ask to see it—here, in outline, is what you'll see!

You'll see how much longer the Type "C" Rollers are than those in the original SKF design.

You'll see the way the rollers are *guided* by a separate floating guide ring, free to move axially.



You'll see the improved brass *window-type* cage—see why it's stronger and more effective.

You can see an exact comparison of original vs. Type "C" capacity and life in the sizes of spherical you use.

SKF®

BALL AND ROLLER BEARINGS

SKF INDUSTRIES, INC.
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YES—We'd like to have an SKF Representative SHOW us WHY the improved SKF Type "C" Spherical provides, size for size, more capacity and longer life than any available spherical design.

Name .....

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Address ..... *State* .....

Mail this coupon NOW and SEE why you can get better spherical roller bearing performance. No obligation, of course.

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mounted unit on which the present latitude and longitude is continuously shown. The computer control allows the pilot to insert the various manual inputs into the system. These are wind force, wind direction, and magnetic variation, and are changed when necessary by the pilot in flight. The computer receives the information of air speed, compass heading, wind force and direction, and continuously computes the change in latitude and longitude. The amplifier houses the power supply, time standard amplifier, and five servo amplifiers that service electrical components in the computer unit. The operating principles are best understood by studying the simplified schematic diagram in Fig. 2.

To operate the set, the pilot simply sets the location of his starting position in latitude and longitude on the indicator unit. From the weather officer he gets the wind direction and force, and from the map the magnetic variation of the area, which is set on the Computer Control. He then turns on a departure switch which starts the computer. Operation is automatic from then on.

In designing these components, Ford engineers were faced with the problem of cramming precision operating mechanisms in to a small space. The computer is of the electro-mechanical analog type, and in miniaturization, the parts actually hang on each other. This particular unit contains three ball-and-disk integrators whose disks are only 1½ in. in diameter, and fourteen of the smallest synchro and servo motors ever designed are used. This is also true of the Indicator with its small gears and differentials.

The new Computer set will operate at aircraft speeds from 70 to 800 knots and in winds up to 200 knots. Ford is also working on a slow speed computer for speeds under 70 knots for use on helicopters.

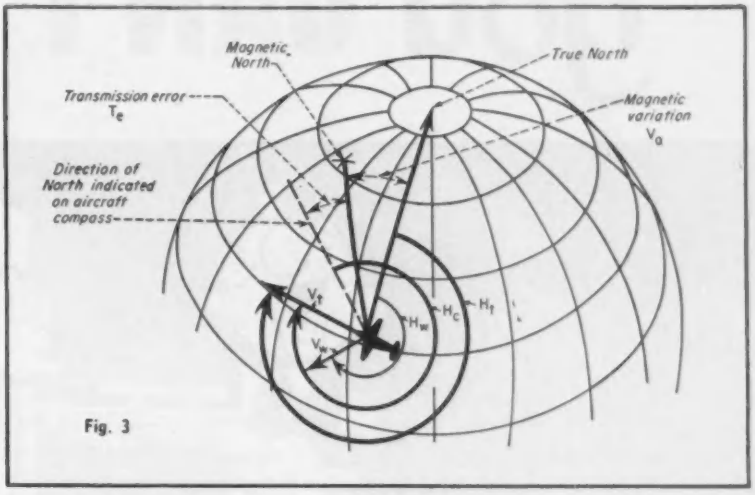

Fig. 3

AN AIRCRAFT IN FLIGHT, with the variables involved in computing the present ground position. The factors affecting position at any time during flight are: true air speed (V_t), true heading (H_t), wind force (V_w), and wind heading (H_w). The true air speed (V_t), wind force (V_w), and wind heading (H_w), are inputs to the system, while the true heading (H_t) is determined from the remaining inputs, namely, the magnetic heading (H_c), compass transmission error (T_e) and magnetic variation (V_a).

NEWS BRIEFS

• An educational and research laboratory in oil hydraulics has been established at the Illinois Institute of Technology offering a program ranging from short courses (the first to be given this summer) to graduate level research. The program was set up at the request of a number of industries using oil hydraulics, with the equipment being donated by the companies in the hydraulics field.

• Fourteen specially designed Sulzer-engined diesel-electric locomotives have been built by the Birmingham Railway Carriage & Wagon Co. Ltd., England for use over the Australian desert. Because they will operate in temperatures of 110-120 F, and must be able to run through sandstorms without damage to the equipment, the entire engine room is pressurized. Air is drawn in by fans through banks of filters, for the engine and generator, and passed along ducts to the force-ventilated traction motors.

• Put into operation recently at Stevens Tech was a new electronic computer with a capacity 60 percent greater than any of its kind built to date. Known as a magnetic drum digital differential analyzer, it was designed and constructed by the engineering college's Experimental Towing Tank Laboratory. A feature which makes the computer unique is its ability to make decisions based on its own computations. For example: with the flight of a guided missile, the computer can decide what rules of flight to apply as the speed of the missile varies between subsonic and supersonic levels.

• For the past three years the Technical Committee 61 (Plastics) of the International Standards Organization has been developing several methods for testing plastics on an international basis. The tests now ready are: absorption of water; flexural strengths; and distortion under heat. Being considered are: determining apparent density of molding compound; and acetone extraction. The idea is to establish a uniform basis for production for international trade. The fourth meeting of this committee will take place this coming October 4th in London.

• With the body built of plastic, a new trailer has passed field tests and is now in quantity production at Strick Co., Philadelphia. The material used is a reinforced fiber glass and polyester resin a little lighter than aluminum but with about the same strength.

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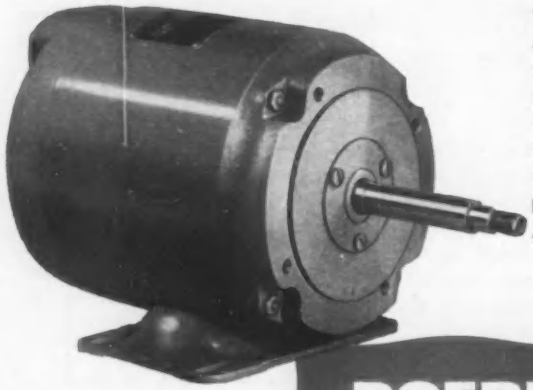
when you buy DOERR MOTORS



If you haven't had a chance to investigate this versatile line of motors regularly used by an outstanding list of machinery manufacturers, it would be well worth your while to learn about the many advantages of using Doerr Motors. Special features and modifications of all types can be furnished, as well as a complete line of standard NEMA ratings. *Write today for more information on DOERR MOTORS.*

Pump motor with special machined face mounting and stainless steel shaft with threads and Woodruff keyway.

Electric Motors from 1/30 to 5 hp. Standard, or designed to your specification.

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Table of Base Pitches for Spur Gears

JOHN D. HOWELL
Walker-Turner Division
Kearny & Trecker Corporation

THESE DATA can be used to supplement the method outlined in "Calculating Design Data from Sample Gears" by Alfred Bishop, *Product Engineering*, July 1953, page 215. This method is concerned with calculating basic design data from gears of unknown origins.

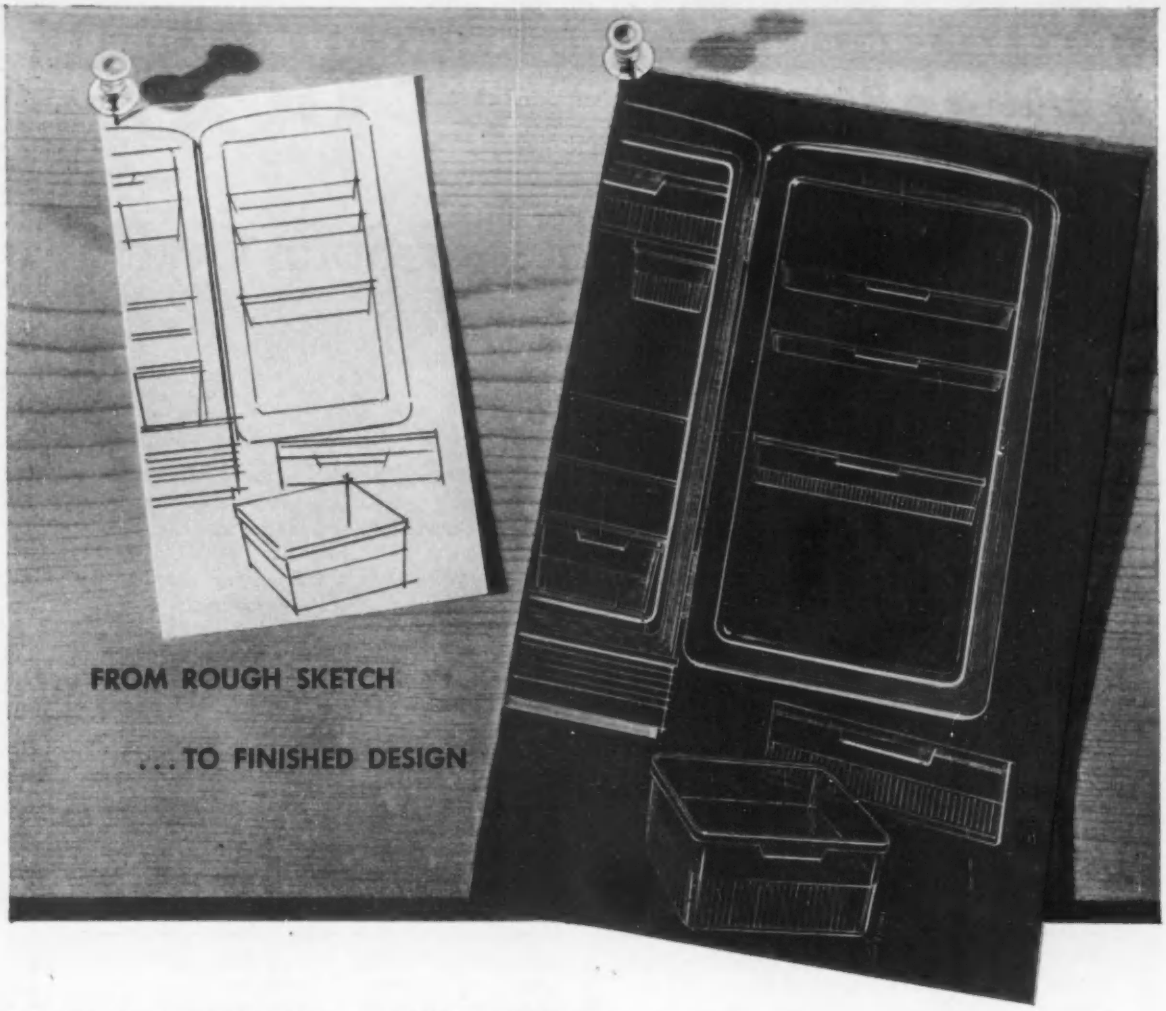
Included are values of base pitch for most of the standard tooth systems used in this country and abroad. If the engineer does not know whether the gear system is, for example, a modified 14½ deg or a metric 20 deg, he may have some difficulty in selecting the standard hob or cutter to duplicate his gear. In the table, the various systems and pitches are arranged in the order of their base pitch lengths from 75 Module and 9 CP down to 100 DP and 0.2 Module. Knowing the base pitch, the designer can find out just which standard gear system was used in cutting the gear.

The table is headed by seven values of the base pitch for a unit pitch or module in seven different systems for use in calculating pitches not given in the main table itself.

TABLE OF STANDARD BASE PITCHES

Inch	Mm.	
3.04153	77.2549	1 DP 14½ PA
2.95212	74.9838	1 DP 20 PA
0.96815	24.5910	1 CP (in.) 14½ PA
0.93969	23.8681	1 CP (in.) 20 PA
0.11622	2.9521	1 Module (Metric, 20 PA)
2.95212	74.9838	1 English Module (20 PA)
0.03700	0.9397	1 CP Metric (20 PA)
8.7169	221.409	75 Module
8.7134	221.319	9 CP 14½ PA
8.4572	214.813	9 CP 20 PA
8.1358	206.648	70 Module
7.7452	196.728	8 CP 14½ PA
7.5546	191.888	65 Module
7.5175	190.945	8 CP 20 PA
6.9735	177.127	60 Module
6.7770	172.137	7 CP 14½ PA
6.5778	167.076	7 CP 20 PA
6.3924	162.367	55 Module
6.0831	154.510	½ DP 14½ PA
5.9042	149.968	½ DP 20 PA
5.8112	147.606	50 Module
5.8089	147.546	6 CP 14½ PA
5.6381	143.209	6 CP 20 PA
5.2301	132.845	45 Module
4.8814	123.989	42 Module
4.8408	122.955	5 CP 14½ PA
4.6984	119.340	5 CP 20 PA
4.6490	118.085	40 Module
4.5328	115.133	39 Module
4.3567	110.660	4½ CP 14½ PA
4.2286	107.406	4½ CP 20 PA
4.1841	106.276	36 Module
4.0679	103.324	35 Module
4.0554	103.007	¼ DP 14½ PA
3.9362	99.978	¼ DP 20 PA
3.8726	98.364	4 CP 14½ PA
3.8354	97.420	33 Module
3.7588	95.472	4 CP 20 PA
3.6306	92.216	3¾ CP 14½ PA
3.5238	89.505	3¾ CP 20 PA
3.4868	88.564	30 Module
3.3885	86.068	3½ CP 14½ PA
3.2889	83.538	3½ CP 20 PA
3.1465	79.921	3¼ CP 14½ PA
3.1381	79.707	27 Module
3.0540	77.571	3¼ CP 20 PA
3.0415	77.255	1 DP 14½ PA

(continued on page 213)



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Five times tougher than general purpose styrene, Lustrex Hi-Test 88 brings new, rugged strength and lasting durability to refrigerator components, housings for air conditioners, radio and television sets, office equipment, appliances, vending machines—and hundreds of other products.

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Hi-Test 88 also retains the exceptional light stability, outstanding chemical properties, and excellent electrical characteristics for which general purpose Lustrex is well known. For further information on the properties and performance of this great new material, and for an informative booklet on new uses for Lustrex Hi-Test 88, just mail the coupon today!

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MONSANTO CHEMICAL COMPANY, Plastics Division, Room 2105, Springfield 2, Mass.

Please send me your booklet on new-design ideas in Lustrex Hi-Test 88.

Name and Title _____

Company _____

Address _____

City, Zone, State _____

TABLE OF STANDARD BASE PITCHES (continued)

Inch	Mm.	
2.9521	74.984	1 DP 20 PA
2.9056	73.803	25 Module
2.9045	73.773	3 CP 14½ PA
2.8191	71.604	3 CP 20 PA
2.7894	70.851	24 Module
2.6624	67.625	2⅝ CP 14½ PA
2.5841	65.637	2⅝ CP 20 PA
2.5570	64.947	22 Module
2.4332	61.804	1½ DP 14½ PA
2.4204	61.478	2½ CP 14½ PA
2.3617	59.987	1½ DP 20 PA
2.3492	59.670	2½ CP 20 PA
2.3245	59.042	20 Module
2.1783	55.330	2¼ CP 14½ PA
2.1143	53.703	2¼ CP 20 PA
2.0920	53.138	18 Module
2.0277	51.503	1½ DP 14½ PA
1.9681	49.989	1½ DP 20 PA
1.9363	49.182	2 CP 14½ PA
1.8794	47.736	2 CP 20 PA
1.8596	47.234	16 Module
1.8153	46.108	1⅞ CP 14½ PA
1.7619	44.753	1⅞ CP 20 PA
1.7434	44.282	15 Module
1.7380	44.146	1¾ DP 14½ PA
1.6943	43.034	1¾ CP 14½ PA
1.6869	42.848	1¾ DP 20 PA
1.6445	41.769	1¾ CP 20 PA
1.6272	41.330	14 Module
1.5732	39.960	1⅝ CP 14½ PA
1.5270	38.786	1⅝ CP 20 PA
1.5208	38.627	2 DP 14½ PA
1.5109	38.378	13 Module
1.4761	37.492	2 DP 20 PA
1.4522	36.886	1½ CP 14½ PA
1.4095	35.802	1½ CP 20 PA
1.3947	35.425	12 Module
1.3518	34.336	2¼ DP 14½ PA
1.3312	33.813	1⅜ CP 14½ PA
1.3121	33.326	2¼ DP 20 PA
1.2921	32.819	1⅜ CP 20 PA
1.2785	32.473	11 Module
1.2166	30.902	2½ DP 14½ PA
1.2102	30.739	1¼ CP 14½ PA
1.1808	29.994	2½ DP 20 PA
1.1746	29.835	1¼ CP 20 PA
1.1622	29.521	10 Module

Inch	Mm.	
1.1060	28.093	2¾ DP 14½ PA
1.0892	27.665	1¼ CP 14½ PM
1.0735	27.267	2¾ DP 20 PA
1.0572	26.852	1¼ CP 20 PA
1.0460	26.569	9 Module
1.0138	25.752	3 DP 14½ PA
0.9840	24.995	3 DP 20 PA
0.9682	24.591	1 CP 14½ PA
0.9397	23.868	1 CP 20 PA
0.9298	23.617	8 Module
0.9076	23.054	15/16 (0.9375) CP 14½ PA
0.8810	22.376	15/16 (0.9375) CP 20 PA
0.8690	22.073	3½ DP 14½ PA
0.8471	21.517	⅞ (0.875) CP 14½ PA
0.8435	21.424	3½ DP 20 PA
0.8222	20.885	⅞ (0.875) CP 20 PA
0.8136	20.665	7 Module
0.7866	19.980	13/16 (0.8125) CP 14½ PA
0.7635	19.393	13/16 (0.8125) CP 20 PA
0.7604	19.314	4 DP 14½ PA
0.7555	19.189	6.5 Module
0.7380	18.746	4 DP 20 PA
0.7261	18.443	¾ (0.750) CP 14½ PA
0.7048	17.901	¾ (0.750) CP 20 PA
0.6974	17.713	6 Module
0.6656	16.906	11/16 (0.6875) CP 14½ PA
0.6460	16.409	11/16 (0.6875) CP 20 PA
0.6392	16.237	5.5 Module
0.6083	15.451	5 DP 14½ PA
0.6051	15.369	⅝ (0.625) CP 14½ PA
0.5904	14.997	5 DP 20 PA
0.5873	14.918	⅝ (0.625) CP 20 PA
0.5811	14.761	5 Module
0.5446	13.832	9/16 (0.5625) CP 14½ PA
0.5286	13.426	9/16 (0.5625) CP 20 PA
0.5230	13.285	4.5 Module
0.5069	12.876	6 DP 14½ PA
0.4920	12.497	6 DP 20 PA
0.4841	12.296	½ (0.500) CP 14½ PA
0.4698	11.934	½ (0.500) CP 20 PA
0.4649	11.808	4 Module
0.4358	11.070	3.75 Module
0.4345	11.036	7 DP 14½ PA
0.4236	10.759	7/16 (0.4375) CP 14½ PA
0.4217	10.712	7 DP 20 PA
0.4111	10.442	7/16 (0.4375) CP 20 PA
0.4068	10.332	3.5 Module

(continued on page 215)

NEW

Zinc-Coated Tubing Offers Full Rust Protection

Have you avoided using welded steel tubing in your products because you couldn't get the rust protection of a zinc coating? You can now obtain Armco Steel Tubing in ZINCGRIP, the special zinc-coated steel that gives unbroken rust protection.

GIVES FULL PROTECTION

Armco ZINCGRIP Tubing is made from flat ZINCGRIP strip by the electric resistance welding process. Before emerging from the pipe machine, the welding flash is planed from the tube and the zinc coating is replaced on the outside by a special metallizing process. The location of the welded and recoated seam can be found only by careful inspection—it's that smooth.

HOW SUPPLIED

Armco ZINCGRIP Tubing is supplied not only in rounds, but in squares, rectangular shapes, hexagons, octagons and special shapes, all with unbroken zinc coatings. That's because the special hot-dip zinc coating on ZINCGRIP takes as severe forming as the steel base. It does not flake or peel.

Rounds are produced in outside diameters from $\frac{5}{8}$-inch through 3 inches and in wall thicknesses of 20 gage through 12 gage, depending on size. For further information call the nearest Armco District Office or write us at the address below.

See our catalog in "Sweet's Product Design File"

ARMCO

ARMCO STEEL CORPORATION

3264 CURTIS STREET, MIDDLETOWN, OHIO
EXPORT: THE ARMCO INTERNATIONAL CORPORATION

TABLE OF STANDARD BASE PITCHES (continued)

Inch	Mm.	
0.3802	9.657	8 DP 14½ PA
0.3777	9.594	3.25 Module
0.3690	9.373	8 DP 20 PA
0.3631	9.222	⅜ (0.375) CP 14½ PA
0.3524	8.951	⅜ (0.375) CP 20 PA
0.3487	8.856	3 Module
0.3379	8.584	9 DP 14½ PA
0.3280	8.332	9 DP 20 PA
0.3227	8.197	⅓ (0.3333) CP 14½ PA
0.3196	8.118	2.75 Module
0.3132	7.956	⅓ (0.3333) CP 20 PA
0.3042	7.726	10 DP 14½ PA
0.3025	7.685	5/16 (0.3125) CP 14½ PA
0.2952	7.498	10 DP 20 PA
0.2937	7.459	5/16 (0.3125) CP 20 PA
0.2906	7.380	2.5 Module
0.2615	6.642	2.25 Module
0.2535	6.438	12 DP 14½ PA
0.2460	6.249	12 DP 20 PA
0.2420	6.148	¼ (0.250) CP 14½ PA
0.2349	5.967	¼ (0.250) CP 20 PA
0.2324	5.904	2 Module
0.2137	5.518	14 DP 14½ PA
0.2109	5.356	14 DP 20 PA
0.2034	5.166	1.75 Module
0.1936	4.918	1/5 (0.200) CP 14½ PA
0.1901	4.828	16 DP 14½ PA
0.1879	4.774	1/5 (0.200) CP 20 PA
0.1845	4.686	16 DP 20 PA
0.1815	4.611	3/16 (0.1875) CP 14½ PA
0.1762	4.475	3/16 (0.1875) CP 20 PA
0.1743	4.428	1.5 Module
0.1690	4.292	18 DP 14½ PA
0.1640	4.166	18 DP 20 PA
0.1614	4.099	1/6 (0.1667) CP 14½ PA
0.1566	3.978	1/6 (0.1667) CP 20 PA
0.1521	3.863	20 DP 14½ PA
0.1476	3.749	20 DP 20 PA
0.1453	3.690	1.25 Module
0.1383	3.512	22 DP 14½ PA
0.1342	3.408	22 DP 20 PA
0.1267	3.219	24 DP 14½ PA
0.1230	3.124	24 DP 20 PA
0.1210	3.074	⅛ (0.125) CP 14½ PA
0.1175	2.984	⅛ (0.125) CP 20 PA
0.1170	2.971	26 DP 14½ PA
0.1162	2.952	1 Module
0.1135	2.884	26 DP 20 PA

Inch	Mm.	
0.1086	2.759	28 DP 14½ PA
0.1054	2.678	28 DP 20 PA
0.1046	2.657	0.9 Module
0.1014	2.575	30 DP 14½ PA
0.0984	2.499	30 DP 20 PA
0.0968	2.459	1/10 (0.100) CP 14½ PA
0.0950	2.414	32 DP 14½ PA
0.0940	2.387	1/10 (0.100) CP 20 PA
0.0930	2.362	0.8 Module
0.0923	2.343	32 DP 20 PA
0.0845	2.146	36 DP 14½ PA
0.0820	2.083	36 DP 20 PA
0.0814	2.066	0.7 Module
0.0800	2.033	38 DP 14½ PA
0.0777	1.973	38 DP 20 PA
0.0760	1.931	40 DP 14½ PA
0.0738	1.875	40 DP 20 PA
0.0697	1.771	0.6 Module
0.0691	1.756	44 DP 14½ PA
0.0671	1.704	44 DP 20 PA
0.0634	1.609	48 DP 14½ PA
0.0615	1.562	48 DP 20 PA
0.0608	1.545	50 DP 14½ PA
0.0605	1.537	1/16 (0.0625) CP 14½ PA
0.0590	1.500	50 DP 20 PA
0.0587	1.492	1/16 (0.0625) CP 20 PA
0.0585	1.486	52 DP 14½ PA
0.0581	1.476	0.5 Module
0.0568	1.442	52 DP 20 PA
0.0543	1.380	56 DP 14½ PA
0.0527	1.339	56 DP 20 PA
0.0507	1.288	60 DP 14½ PA
0.0492	1.250	60 DP 20 PA
0.0475	1.207	64 DP 14½ PA
0.0465	1.181	0.4 Module
0.0461	1.172	64 DP 20 PA
0.0422	1.073	72 DP 14½ PA
0.0410	1.041	72 DP 20 PA
0.0380	0.966	80 DP 14½ PA
0.0369	0.937	80 DP 20 PA
0.0349	0.886	0.3 Module
0.0346	0.878	88 DP 14½ PA
0.0335	0.852	88 DP 20 PA
0.0317	0.805	96 DP 14½ PA
0.0308	0.781	96 DP 20 PA
0.0304	0.773	100 DP 14½ PA
0.0295	0.750	100 DP 20 PA
0.0232	0.590	0.2 Module

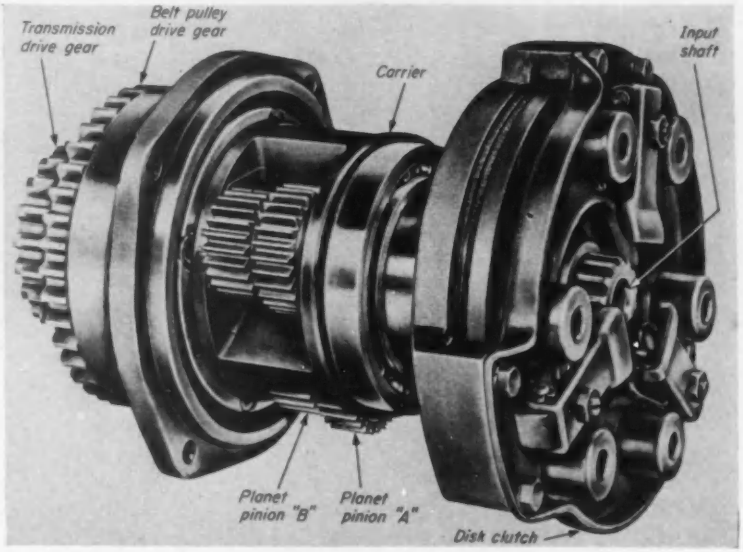
Torque Amplifier Increases Pulling Power

Changing travel speed and pull-power in any gear without stopping, shifting, or touching the throttle is possible with this new torque amplifier, a planetary-gear speed-reduction unit installed between the engine clutch and the regular 5 speed transmission. Used on a tractor, the torque amplifier (TA) boosts pull power up to 45 percent, and gives good performance in hard or soft areas of ground. Two speeds in each gear give 10 speeds forward, and power flow to the rear wheels is uninterrupted.

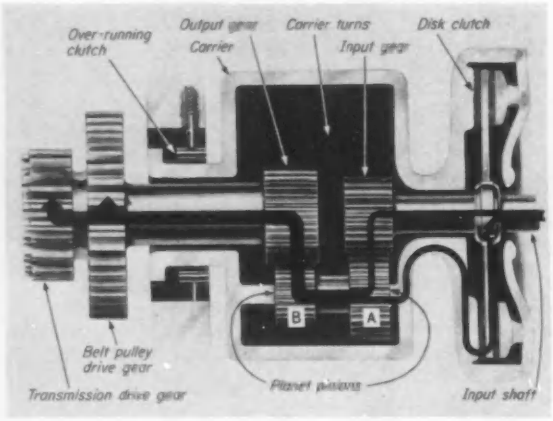
The transmission drive gear must turn with the TA unit because the output gear is in mesh with the planet pinion "B," which is locked to keep it from turning on its shaft. Since all parts are locked and turning as a unit, (direct-drive) speeds are obtained.

Since the speed reduction takes place before the transmission, the belt pulley will operate at reduced speed. In direct drive, pulley speed is 899 rpm. In TA drive, speed is 608 rpm.

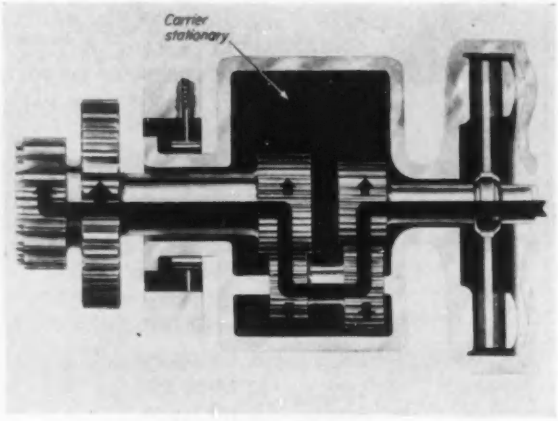
International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill.



THE COMPLETE TORQUE AMPLIFIER UNIT. The disk clutch operates within a dry compartment of the tractor clutch housing. The rest of the unit is lubricated from the oil in the main transmission. The unit consists of a double-faced clutch, planetary gearing with carrier, and a cam-roller over-running clutch. In direct drive, the TA disk clutch is engaged. The engine then drives the planetary gearing, carrier, and input shaft as a unit (same direction and speed as the engine).



CROSS-SECTION of the torque amplifier unit showing, left, the TA clutch engaged for direct drive and, right, disengaged for the TA, or speed-reduction drive. In TA drive—33 percent speed reduction, the disk clutch is disengaged. The carrier tends to revolve opposite to engine rotation, due to the counter rotation force set up by the input gear driving planet pinion "A". But, the carrier is locked by the cam-roller clutch which automatically engages against counter rotation. With the carrier locked, the TA unit operates like a conventional counter-shaft transmission. Planet pinions "A" and "B" are driven by the input gear, and "B" drives the output gear. Power is transmitted through 3 planet pinion sets in the actual TA unit. The rpm of the transmission drive gear is reduced 1.482 to 1. Twenty-three twenty-eighths is the ratio between the 23-tooth input gear and the 28-tooth planet pinion "A". The same ratio also exists between the 23-tooth planet pinion "B" and the output gear.



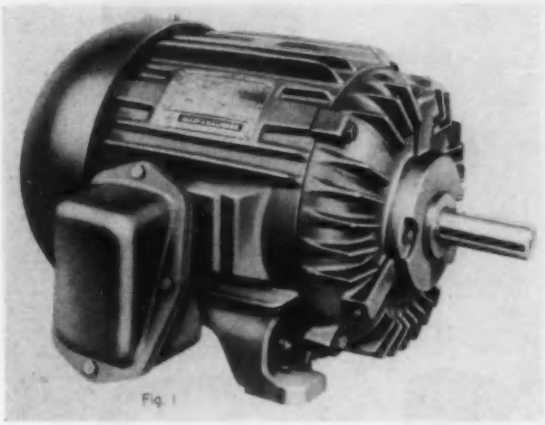


Fig. 1

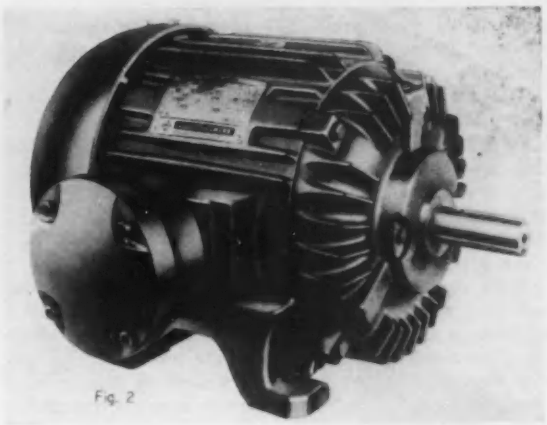


Fig. 2

New A-C Squirrel Cage Induction Motors

In frame sizes 326 and smaller, a completely new line of alternating current squirrel cage induction motors has been developed with many features. The new motors are designated the type G and are available in the types shown. Fig. 1, type GZ totally enclosed, fan-cooled; Fig. 2, type GZZ totally enclosed fan-cooled, explosion-proof motor; Fig. 3, types G, AP, and APWW open motors.

As an example of the change in these rerated motors, a new 5 hp, 1800 rpm general purpose NEMA design B drip-proof, squirrel cage motor will be on a 215 frame and will have the following qualifications: temperature, rise 40 C; locked rotor torque, 185 percent minimum; breakdown torque 225 percent minimum; locked rotor current at 220 V, 90 amp. max; slip 5 percent maximum. Under old standards this motor was on a 254 frame.

Construction-wise, the new models will have cast-iron frames and end shields. Rotors will be pressure-cast of aluminum. Bearings will be grease-lubricated, medium series, double shielded ball bearings, capable of relubrication without dismantling the motor. Stator windings will be the random or mush wound type of heavy Formvar-coated wire in semi-closed slots. Stator will receive multiple dips and bakes to assure greater protection.

In the new open motor, type G, the intake openings in the end shields will have greater protection than in the old design. Located in the bottom half of the end shield, these openings are high enough above the base to minimize the probability of the incoming air sweeping dust or lint from the floor or base. All continuous rated totally-enclosed motors under the new design (type GZ and type GZZ), even the smallest integral hp sizes, will be fan-cooled.

Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.

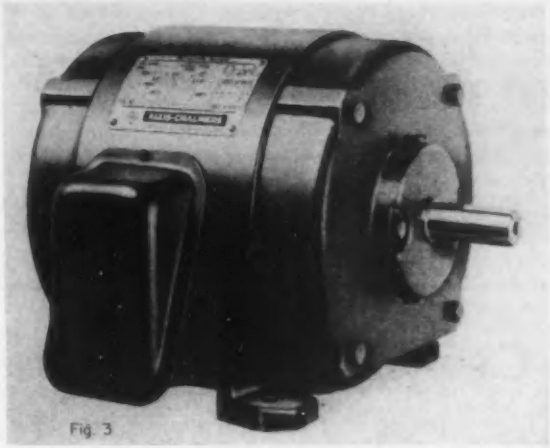


Fig. 3

Horsepower-Frame Chart

Type GZ, totally enclosed, fan-cooled

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM	720 RPM	600 RPM
½	....	....	....	182	....	....
¾	....	....	182	184	....	....
1	....	182	184	213	213	215
1½	182	184	184	213	215	254U
2	184	184	213	215	254U	256U
3	184	213	215	254U	256U	286U
5	213	215	254U	256U	286U	324U
7½	215	254U	256U	284U	324U	326U
10	254U	256U	284U	286U	326U	....
15	256U	284U	324U	326U	....	....
20	286U	286U	326U	....	....	....
25	326U	326U	....	....	....	....

Frame numbers listed above for 110, 208, 220-440, 550 volts.

CONTINUED ON PAGE 218

Stepless Adjustable-Speed Drive

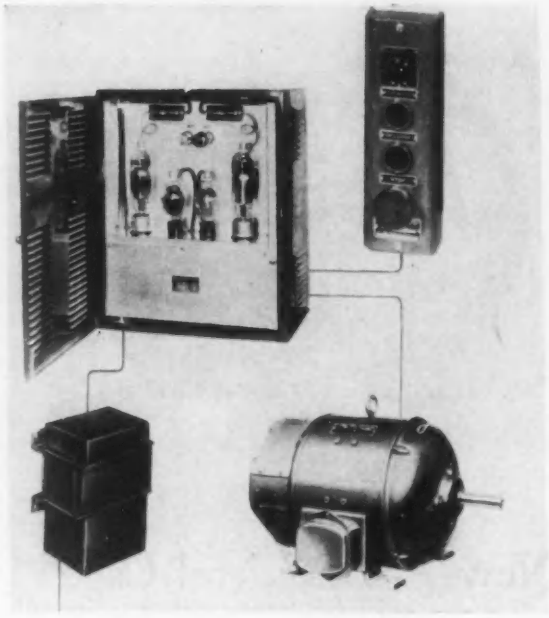
Four important advantages are claimed for this new adjustable-speed drive: (1) precision speed control; (2) unusually wide speed range; (3) adaptability to a variety of optional electrical and mechanical modifications; (4) the use of new, simple, reliable electronic circuits.

The unit has been designed for operation from a-c power lines and is available with d-c drive motors in standard NEMA frame sizes, ¾ to 15 horsepower. Built with speed ranges of 5:1, 20:1, or 50:1, with 100:1 available for some applications, the unit's speed regulation is claimed to be especially precise. When used with optional tachometer feedback equipment, the regulation will be plus or minus ½ percent.

A variety of optional control features is also available, including inching, jogging, threading speeds, controlled acceleration and deceleration, dynamic braking, and reversing. The manufacturer also claims the use of simple, reliable electronic circuits, in this new unit, that have been tested for long life and dependability under severe industrial conditions.

The complete unit consists of an anode transformer, electronic control panel, pushbutton station, and a specially designed adjustable-speed d-c. drive motor. Anode transformer and control panel may be mounted in any convenient out-of-the-way location, with drive motor and pushbutton station available in any desired enclosure-open, drip-proof, splash-proof, totally-enclosed, or explosion-proof. Standard safety features include a fail-safe circuit in case of tube failure, and current-limit control to safeguard driven machine and motor from overload, jamming, or too rapid acceleration.

The unit—the Electronic Select-A-Spede—is especially designed for applications where flexibility and close speed control are necessary. These include such units as test equipment, machine tools, conveyors, balancing machines, paper machines, tire-building machines, welding positioners, and similar units.



Louis Allis Co., Milwaukee 7, Wis.

Cam and Gear Mechanism In Rotary Limit Switch

Latest in the parade of control devices is a rotary limit switch with a cam and gear mechanism. Designed for use where movement can be expressed as shaft revolutions, its main application is intended for reverse movement between two limits, (such as the opening and closing of electrically operated doors, windows, large valves and machinery). The switch works as an automatic control.

According to the manufacturer, a large selection of gear ratios, plus easily adjusted, positive locking cams, will assure an unlimited control of movement between any two limits.

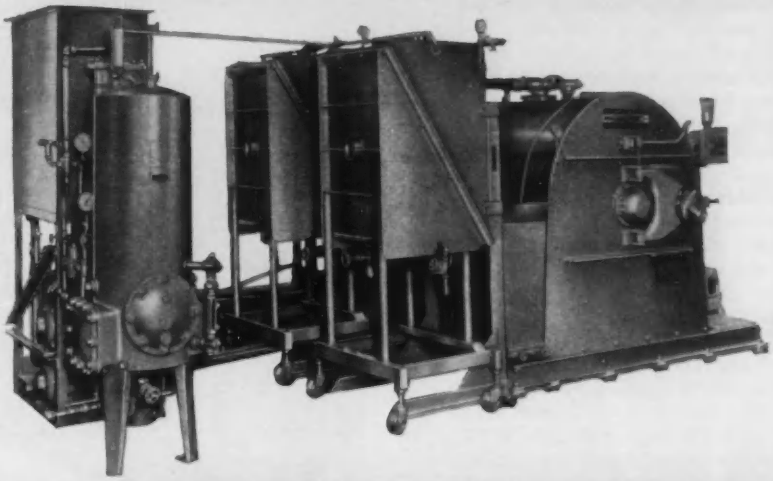
High quality bronze and steel gears are supported by Oilite bearings. The ½ in. hardened steel drive shaft extends beyond the case to make possible easy linkage to the motive force.

The enclosure is fabricated of a special fibreglass alloy that is resistant to shocks, acid solutions, alcohols, hydrocarbons and heat (NEMA Type 4 and 7 enclosures are also available.). The electrical circuit has two cam operated micro switches that supply one open and one closed circuit for each travel position.

Gemco Electric, 25685 W. 8 Mile Road, Detroit 19, Mich.

CONTINUED ON PAGE 220

HOW TO CLEAN WITH SUPER-STRONG SOLUTIONS



Crane Packless Diaphragm Valves . . . find ready application in products of all kinds. Crane design assures long diaphragm life, positive shut-off in case of diaphragm failure, accurate seating, better flow control. They're easy to operate . . . simple to maintain. Specify your choice of body materials, trim materials, and linings. Unlined valves available with screwed or flanged ends. Lined valves, flanged ends only. Sizes up to 6-inch.

another successful product design with piping equipment by CRANE

Bring on your toughest dry cleaning jobs—this specially designed *Trucleen* unit by The American Laundry Machinery Co., of Cincinnati uses soap solutions 5 to 50 times stronger than previously possible. Featuring an automatic two-bath operation, the unit handles 105 pounds of work each 40 minute cycle.

Like many manufacturers, The American Laundry Machinery Co. designed piping dependability into their product by specifying from the familiar Crane Catalog. And it's a time saver, too, containing full information on the world's most complete selection of quality piping . . . with sizes and dimensions, temperature and pressure ratings, plus helpful details on materials and construction.

YOU'LL FIND IT HERE ...IN YOUR CRANE CATALOG

THE BETTER QUALITY... BIGGER VALUE LINE... IN BRASS, STEEL, IRON

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

Shock Resistant Gasket Mounted Valve

Fully shock resistant, a new gasket mounted, solenoid operated, 4-way valve has been developed with impact and shock eliminated by a scalloped design on the valve spool, which opens or closes gradually increasing or decreasing areas to the ports as the spool is moved left or right.

Metering grooves built into the spool, plus a choke block assembly to control the speed of the spool, aid in allowing the flow to enter and leave the valve with an easier, smoother action; and in addition permit the use of the valve as a de-compression valve and a 4-way valve in one.

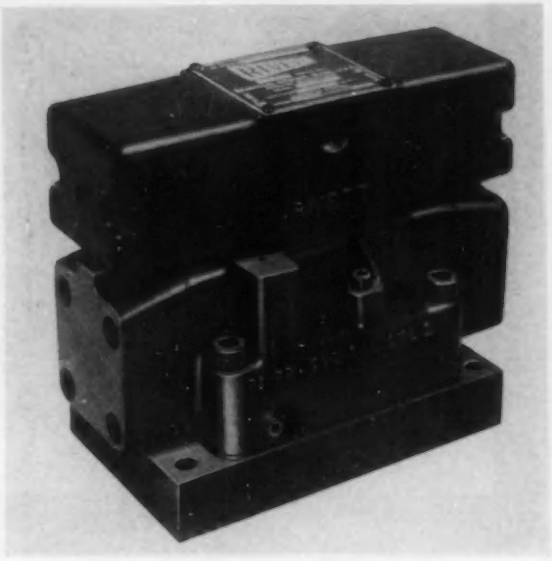
The new series 6600 valve has been designed for 3000 psi oil hydraulic service and meets all JIC requirements. Two basic valves can be used for five sizes: by only changing pipe tap size the 1 in. valve may be used for $\frac{1}{2}$, $\frac{3}{4}$ or 1 in. I.P.S., and the $1\frac{1}{2}$ in. valve for $1\frac{1}{4}$ and $1\frac{1}{2}$ inches.

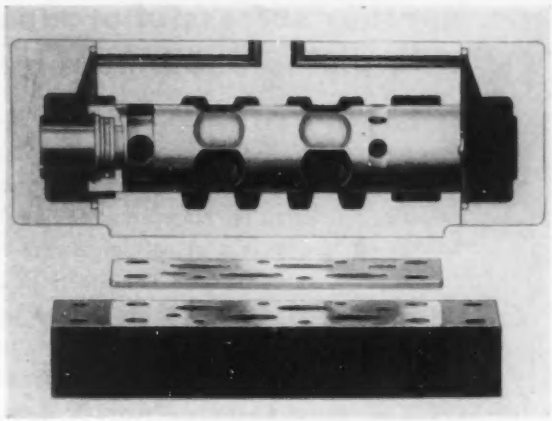
Lower pressure drop and less back pressure are two additional features. Lower pressure is attained by designing larger, unrestricted passages, permitting a greater flow area. For example, the $\frac{3}{4}$ in. size is rated at 28 gpm at 15 ft. per sec., which is said to be a greater flow at less velocity than valves previous offered. According to the manufacturer this design means greater efficiency, longer life, less wasted horsepower and less shock.

The pilot valve, on top in the illustration at right has a roomy wiring box with a terminal wiring strip. Continuous duty, shock mounted solenoids are dust sealed and moisture resistant, and have low current requirements. The solenoids operate on only 3.6 amps inrush and 0.45 amps holding at 115 volts. Also, $\frac{1}{2}$ in. conduits at each side of the valve allow easy connections. The pilot valve may be used as a direct solenoid valve by itself for control of 3000 psi. It is furnished in $\frac{1}{4}$ in. size, for 3.6 gpm.

Other features of the series 6600 valve offering a broader opportunity for control of hydraulic power are: a nylon piston guide serves as a good bearing and offers long life; detent clip prevents piston from shifting when valve is mounted in any position; small, compact in size; four long sealing surfaces on the spool provide a close fit with the valve bore; and a high tensile, nickel alloy body.

Four standard models are offered: double solenoid, standard action; double solenoid, spring centered; single solenoid, spring return; and, single solenoid, spring centered. Seven spool designs are available for 3-way and 4-way control. The valve is furnished with gasket mounting only, or with threaded sub-plate.





Rivett Lathe & Grinder, Inc., Boston, Mass.

A COMPLETE LINE OF multiple circuit timers for use in vending machines are especially adapted to coin machines which operate on a pre-set time interval. Typical applications include soft drink and coffee dispensers, automatic popcorn venders. The multi-circuit timers may be set for on and off periods with as many circuits as desired. Rating: 15 amps, 1,000 watts at 115 v, 60 cycle. Zenith Electric Co., 152 W. Walton St., Chicago 10, Ill.

DESIGNED FOR USE on evaporative-cooler, attic, air-circulating, and window fans, a new line of small, lightweight, fhp motors have resilient bases, and can be mounted in any position. The line is made up of split-phase and capacitor-start types. The split-phase models are rated at $\frac{1}{6}$, $\frac{1}{4}$ and $\frac{1}{3}$ hp, 115 v, 60 cycles. The capacitor-start models are rated at $\frac{1}{2}$ and $\frac{3}{4}$ hp, 60 cycles, 115 or 230 volts. General Electric, Schenectady 5, N. Y.

TO A LINE OF FREE WHEELING CLUTCHES has been added a narrow type ball clutch which, because of its small axial space, is especially suitable for back stop applications. The balls are backed up with neoprene cushions. This insures perfect engagement and disengagement at frequencies up to 60 per second. All springs and spring cages have been avoided to reduce the free wheeling torque and eliminate heating. Odin Corp., Castleton, Ind.

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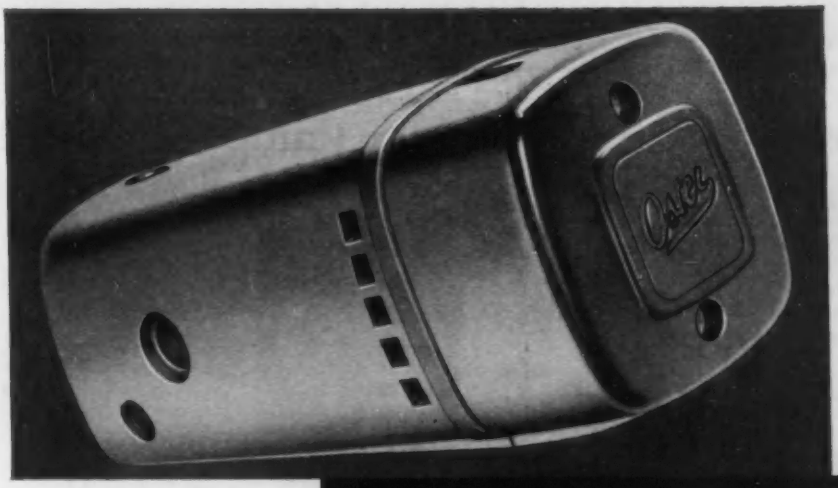
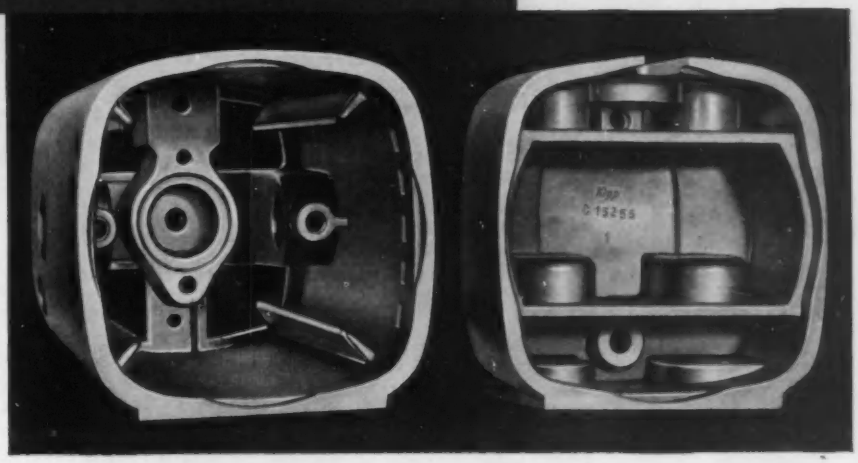


the OUTSIDE for eye appeal

the INSIDE for function



...with MADISON-KIPP zinc and aluminum die castings

Any designer will be intrigued by studying these new popular kitchen mixer parts by Oster. The outside is shaped to suit a famous designer for "looks". The inside accepts the "works" designed by the inventive engineers.

You also may be able to add sales value without cost penalty by letting Madison-Kipp work with you on your new designs.

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MADISON-KIPP CORPORATION
206 WAUBESA STREET • MADISON 10, WIS., U. S. A.

• Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High Speed Air Tools

Vacuum Booster Pump for Cleaner Pumping Action

"Model MB" is a rotary positive displacement pump equipped with mechanical shaft seals. Its use: as a vacuum stage in the low pressure range where single stage vacuum pumps have poor volumetric efficiency.

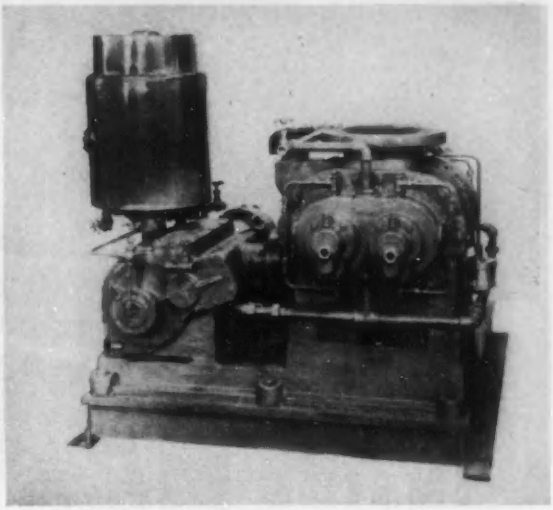
Specifically designed to exhaust into the inlet of a single stage pump (acting as a second stage or backing pump), the new unit requires no sealing fluid. Being free of volatile materials, the booster acts as a positive displacement compressor to retard the backstreaming of oil vapors into the vacuum system. Result: cleaner pumping action than that of either the usual type of compound mechanical pump or an oil ejector or oil booster pump.

Its overall performance characteristics should make the unit particularly attractive in the fields of vacuum processing (such as refining titanium, zirconium and other metals), metallized coating, foundry research, the pharmaceutical industry, and other vacuum processes where fast, high vacuum is a vital factor.

The first of this new series of pumps is now in production. This model (MB 1200) is combined with a single stage 125 cu ft pump to form a unit capable of producing a blank-off pressure of one micron. At one micron pressure, the pumping speed is about 750 cfm; in the pressure range from 10 microns to 1 mm Hg, the pumping speed is about 1,000 cfm. At high vacuum the unit requires about 5 hp, and at an inlet pressure of 15 mm Hg, about 15 horsepower.

The unit has a broad pumping speed versus pressure range compared with oil ejector (or booster) pumps and will continue to pump efficiently at pressures well in excess of the stalling pressure for oil ejectors (a desirable feature in systems in which large outbursts of gas may occur, requiring positive displacement evacuation to quickly recover the proper operating pressure).

The model is arranged for automatic control. The MB 1200 pump, provided with a built-in bypass valve, is directly connected to a 10 hp, 1800 rpm motor; the single stage, 125 cfm backing pump has a 5 hp, 520 rpm gear motor. Both units are assembled on a common base plate.



The pump remains idle with bypass open to the vacuum vessel until the single stage backing pump roughs the system down from atmospheric pressure to a predetermined set pressure. At this pressure the MB automatically goes into operation (with bypass closed), and further evacuation is performed by the combined unit. If—during this processing cycle—a gas burst sufficient to raise the pressure above the predetermined set pressure level should occur, the MB shuts down automatically, and the system pressure is reduced to the set value by the backing pump.

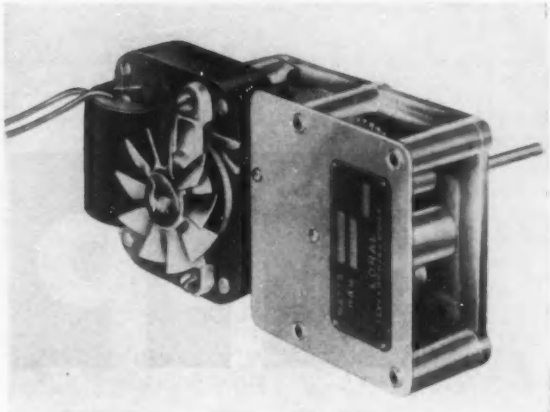
New York Air Brake Co., Kinney Mfg. Div., Boston, Mass.

Motorized Sub-Fractional Speed Reducer

For use in rotisseries, vending machines, rotary display units, dispersers, this compact motorized, sub-fractional hp speed reducer is housed in a precision machined die-casting and powered by a shaded, two-pole induction motor.

A typical unit has an output speed of 9 rpm (although output speeds down to 1 rpm are available) at 16 watts input and delivers a full load torque of 150 in.-oz. Normal power supply is 115 volts, 50/60 cycles, but special motors can be wound. Horsepower ranges from 1/500 to 1/75, depending on the coil and stack size.

The unit's porous bronze bearings and large oil reservoirs assure self-lubrication, and high speed nylon gears guarantee quiet operation. Other features: For cool operation, a fan is standard on all units; the paper layer coils are vacuum impregnated for ideal operation under maximum temperature and humidity.



Loral Electronics Corp., 795 East 140th St., New York 54, N. Y.

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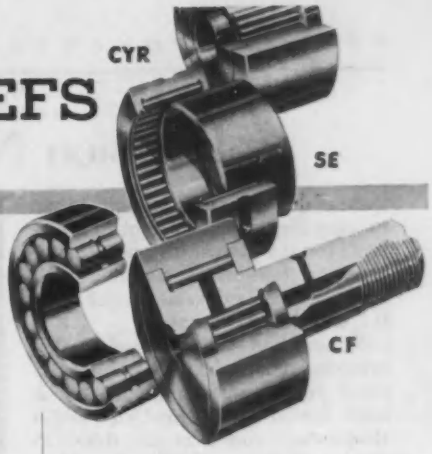
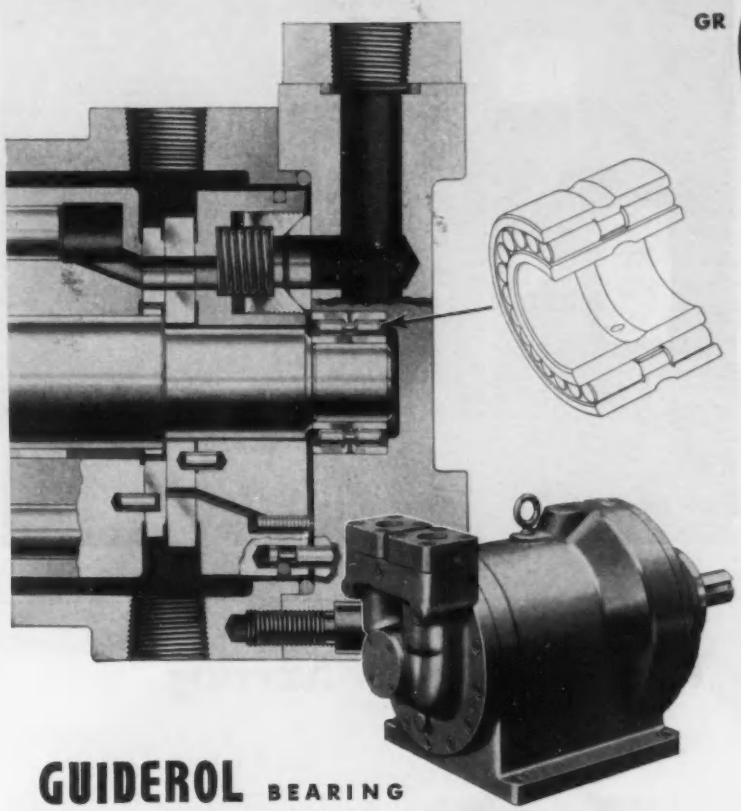
McGILL BEARING BRIEFS





GUIDEROL BEARING

used in pilot model Oilgear Motor

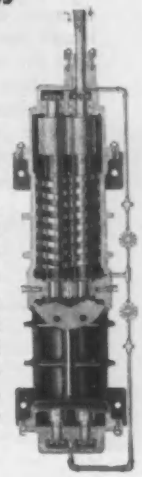
SHOWS NO WEAR AFTER 4000 HOUR TEST

The Oilgear Company, Milwaukee, Wisconsin, a regular McGill bearing user, has been testing a pilot model of a new 60 HP Axial Type Hydraulic Motor equipped with Guiderol Bearings for over a year. After 4000 hours of full load operation, the Guiderol Bearing used on the pilot end of the motor shaft was removed and inspected. It was still in perfect condition showing no internal wear.

This new line of lighter and faster operating axial piston units take advantage of the Guiderol bearing's assured freedom from skewing and extra load capacity in reduced radial bearing space.

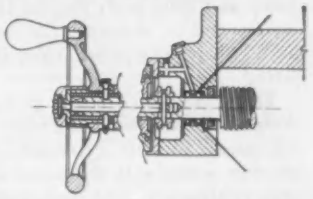
Mr. Ernst Wiedmann, Oilgear Chief Engineer, is enthusiastic about the performance of the Guiderol Bearings. He says: "They are the best full-type roller bearings for our hydraulic pumps and motors." As a result he is changing old specifications for this type of bearing to Guiderol and including Guiderol Bearings on all new developments.

WARREN-QUIMBY ADOPTS GR BEARINGS FOR MAXIMUM RADIAL LOADS



Warren Steam Pump Company has adopted Guiderol Bearings at five points of maximum radial load in this Warren - Quimby Vertical Screw Pump. The Guiderol Bearings have more load carrying capacity in the limited space available and enable vertical mounting of the pump without roller skewing or locking.

KEARNEY & TRECKER FINDS LIFE FACTOR INCREASED IN TABLE FEED APPLICATION



The life factor of the shaft bearing on the table feed screw of Kearney & Trecker Milling Machines has been increased by the simple process of changing to Guiderol Bearings. These bearings increased capacity, performance and bearing life.

BEARING SELECTION GUIDE
A new 140-page Bearing Selection Guide, complete with 30 pages of vital engineering data, has been released by the McGill Manufacturing Co. Ask for Catalog No. 52.

McGILL® — Precision Bearings
McGILL MANUFACTURING COMPANY, INC.
201 N. Lafayette Street, Valparaiso, Indiana

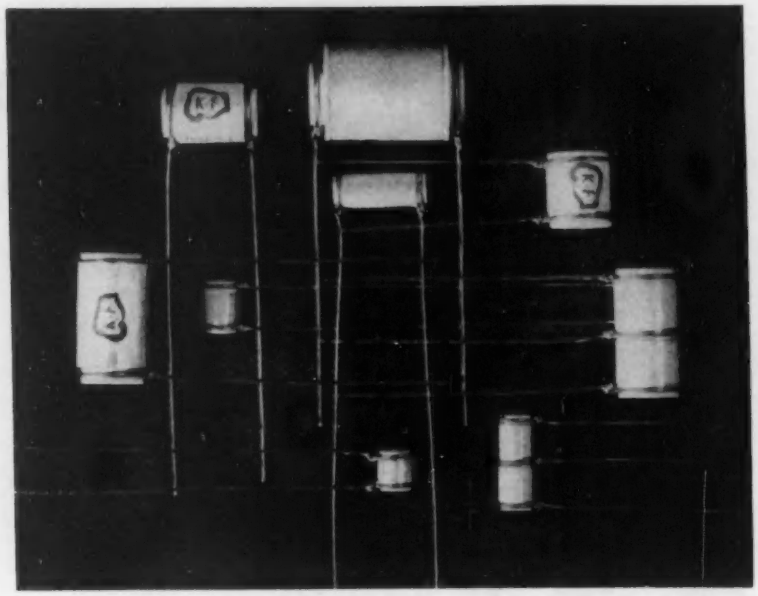
Precision Non-Inductive Resistors

Available in exact resistance values to accuracies of one percent, 0.5 percent, and 0.1 percent, this new line of precision resistors is available in a series of standard value ranges from 0.1 ohm to one megohm.

Wound non-inductively on non-hygroscopic ceramic bobbins and impregnated for moisture protection, these units exhibit low thermal emf and a temperature coefficient of 0.000025 ohms per degree Centigrade. Nine sizes are supplied, ranging in power capability from $\frac{1}{4}$ watt to one watt; in diameter from $\frac{1}{4}$ in. to $\frac{3}{4}$ in.; and in length from $\frac{5}{16}$ in. to $1\frac{1}{4}$ inches.

In the standard units, values under 800 ohms are wound of Manganin wire, while values over 800 ohms are supplied in Evanohm. Special alloys can be used and units can be produced with special resistance values.

K-F Development Co., 2692 Spring St., Redwood City, Calif.



Pumps For Hydraulic Power Steering

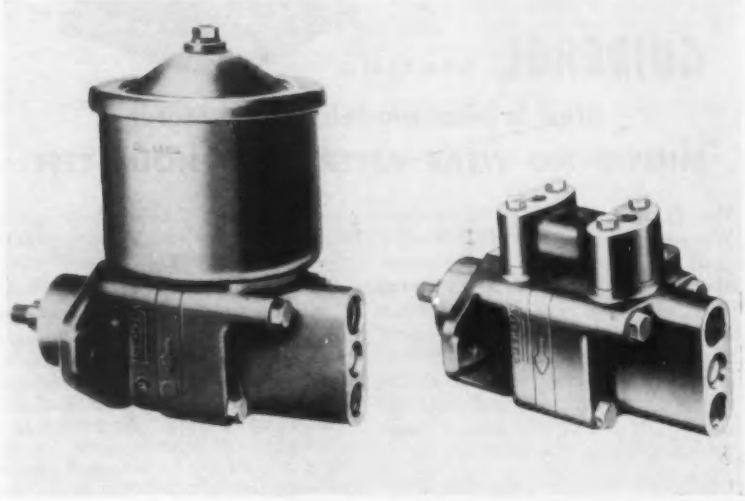
Two new pump series are now available for hydraulic steering systems. Series VT16 at left in the illustration, consists of a vane type hydraulic pump, flow control and overload relief valves, and integral oil reservoir. Series VT17 at right, is comprised of an identical pump and valve units without the reservoir, and is designed for installations where a separate tank is preferred.

The series VT16 power package is designed for use with a hydraulic steering booster to form a complete power steering system with the simplest possible installation. The unit need only be bolted on, coupled to the engine—usually by belts, and two hydraulic connections made to the booster. Overload protection is built in. Smooth steering performance is obtained with the flow control valve which insures a smooth and relatively constant supply of oil to the booster, regardless of engine speed variations.

Other features of the series VT16 pump include long life, no load starting and automatic maintenance of optimum running clearances for continued high efficiency, through the use of a special hydraulic balance design and vane pump construction.

Series VT16 and VT17 power packages are available in three factory-set flow control capacities, $1\frac{1}{2}$, $2\frac{1}{2}$ and 3 gpm. Maximum pump drive speed depends upon particular installation requirements and may be as high as 5000 rpm.

Vickers Inc., 1454 Oakman Blvd., Detroit 32, Mich.



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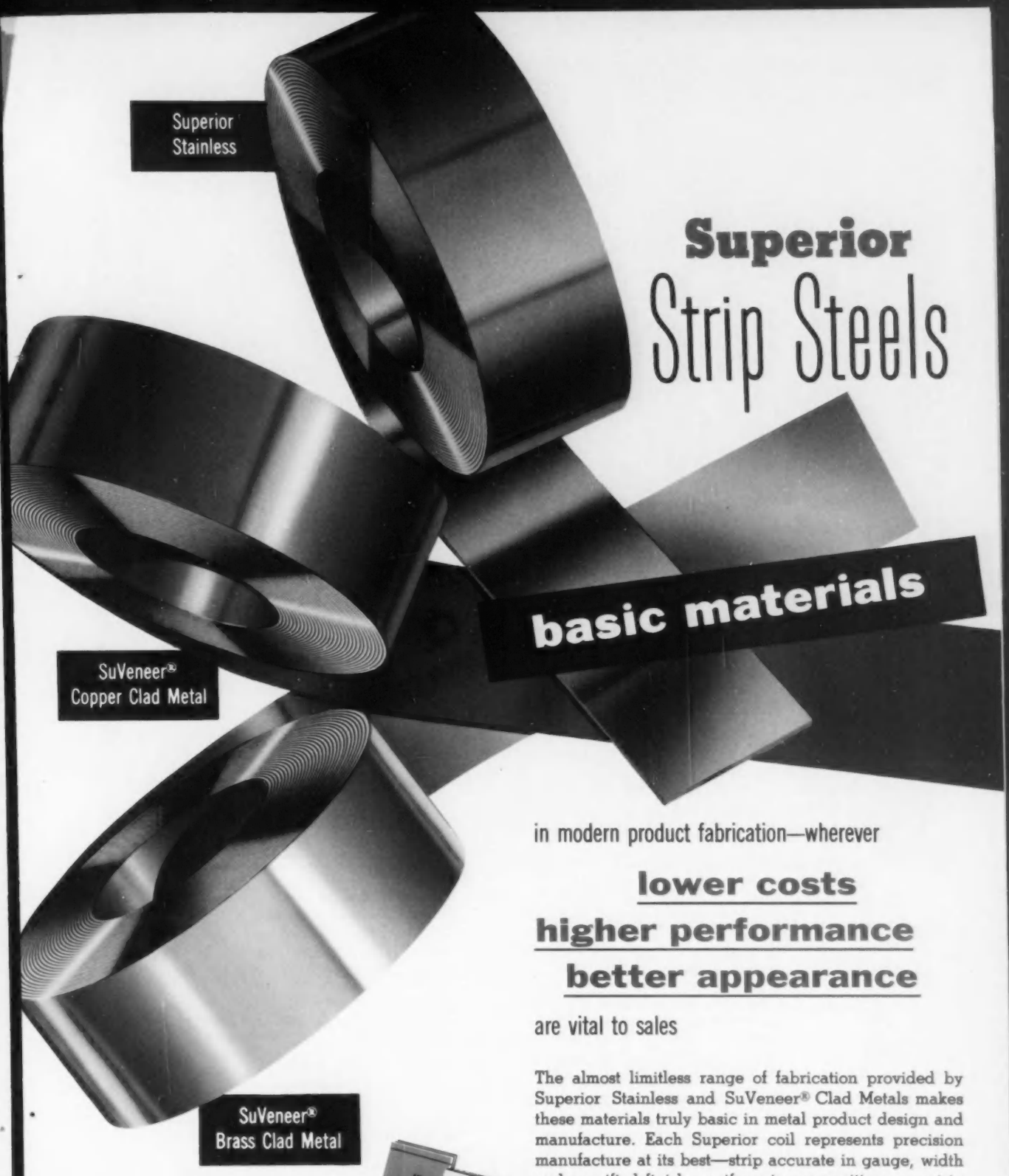


Superior Strip Steels

basic materials

in modern product fabrication—wherever

lower costs
higher performance
better appearance

are vital to sales

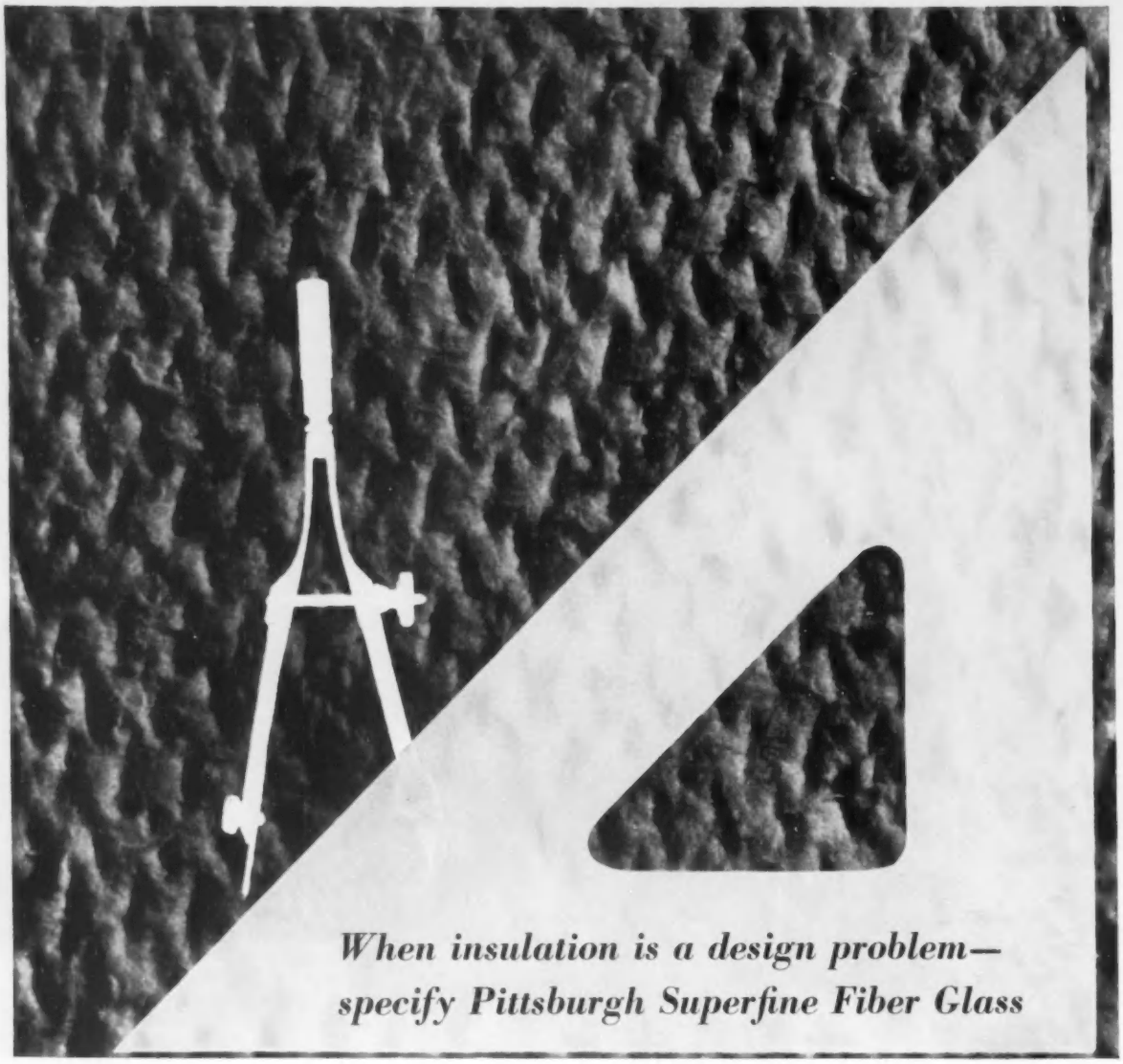
The almost limitless range of fabrication provided by Superior Stainless and SuVeneer® Clad Metals makes these materials truly basic in metal product design and manufacture. Each Superior coil represents precision manufacture at its best—strip accurate in gauge, width and specified finish—uniform in composition—exact in temper for your particular need. *Check with us!*

"QUICK FACTS on Superior Strip Steels" . . . and "An Introduction to Clad Metals" . . . two useful, free publications you should have. Write for them today!

Superior Steel
CORPORATION
CARNEGIE, PENNSYLVANIA

VISIT OUR EXHIBIT at the 2nd BASIC MATERIALS EXPOSITION

Superior will again present an interesting product showing of Stainless and SuVeneer Clad Metals during the 2nd Basic Materials Exposition, Chicago Amphitheatre, May 17-20, 1954. Come visit with us—there'll be much to see and discuss, to your profit!



When insulation is a design problem— specify Pittsburgh Superfine Fiber Glass

Because Pittsburgh Superfine is composed of extremely fine glass fibers (3/100,000″-20/100,000″ dia.), it provides superior thermal and acoustical insulating properties in comparison to conventional fiber glass insulation.

As an example of the exceptional insulation qualities you can add to your product components or assemblies, consider these general specifications:

Thermal insulation—PPG Superfine has a thermal conductivity, k, at a mean temperature of 75° F. of .21 to .27 B.t.u's per sq. ft., per hour, per degree F., per inch thickness, depending on density.

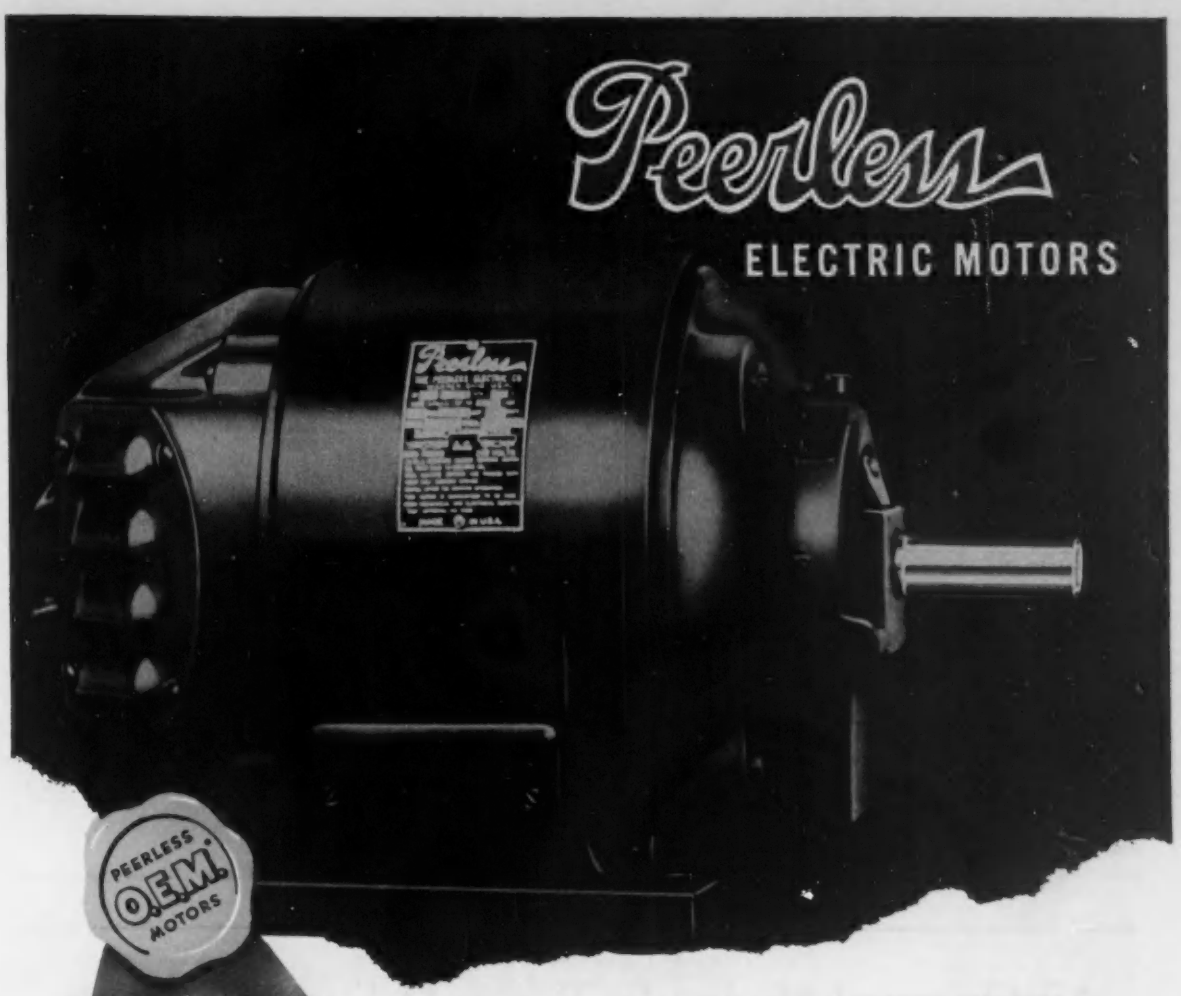
Acoustical insulation—Noise reduction coefficients of a 1″ thickness are as high as .70 with sound absorption curve indicating highest efficiency in the range of most irritating noises.

For complete information and technical staff assistance on your particular insulation problem as applied to product design, write our executive offices or district sales offices in Chicago, Cincinnati, Cleveland, Detroit, New York or Washington. Pittsburgh Plate Glass Company, Fiber Glass Division, One Gateway Center, Pittsburgh 22, Pennsylvania.

FIBER GLASS

PAINTS · GLASS · CHEMICALS · BRUSHES · PLASTICS

PITTSBURGH PLATE GLASS COMPANY



It's like having your own motor department

★ *Original Equipment Manufacturer*

We would like to share our facilities and knowledge with you. If you're trying to fit a standard motor to a custom job — if you want special characteristics in your motors — THEN YOU WANT PEERLESS ELECTRIC. It's like having your own motor department.

Peerless engineers work with your engineers to give your motors the torque, speeds and other electrical and mechanical qualities that you require. Then, because of our size, which gives us a great deal of flexibility, we can make minor changes as required without fuss or bother.

To get started, just pick up the phone and call . . . ask for me if you wish. I'll see that you talk to the specialist who can help you most. You can have custom motors at a competitive price. We build them — PEERLESS GOLD SEAL MOTORS . . . the motors designed for the products they power.

Ralph Kroehle
President

Peerless Electric

THE PEERLESS ELECTRIC COMPANY
WEST MARKET ST. · WARREN, OHIO
MOTORS · FANS · BLOWERS

Portable Test Stand Designed for Flexibility

"Air—where, when, and how you want it" is the manufacturer's claim for this portable high pressure test stand. Air at pressures up to 3500 psi is supplied by a 16 to 26 cfm (free air) three-stage compressor to test complete high-pressure systems or their components.

A selector switch provides air at any two desired pressures within an accuracy of two percent; pressure is maintained by automatic recirculation. If dry air is required, the unit has a dehumidifier which will lower the dew-point of 100 F, 100 percent relative humidity intake air to —67 F.

Alternate drives are an electric motor (220 volts, 3 phase, 60 cycles) or a four-cylinder gasoline engine. The unit can be supplied mounted on a Jeep.

The temperature and the pressure of the air to within ±¼ percent are indicated on easy-to-read panel-mounted gages. Controls are arranged for ease of operation.

The unit has been built for long, dependable operation, and is enclosed for all-weather service. Features that insure safety and lasting quality include welded steel construction, instant-action forged valves, stainless-steel tubing and fittings, blow-out disks, and shatterproof glass.

Developed to the standards of the armed services, the stand has already received wide acceptance in the jet aircraft industry, and should find applications in other aircraft and industrial uses such as proof-testing high-pressure receivers, piping, and valves; pressurizing oil wells; charging torpedoes; salvaging sunken ships; testing landing gear; air circuit breakers; testing gun-firing mechanisms.

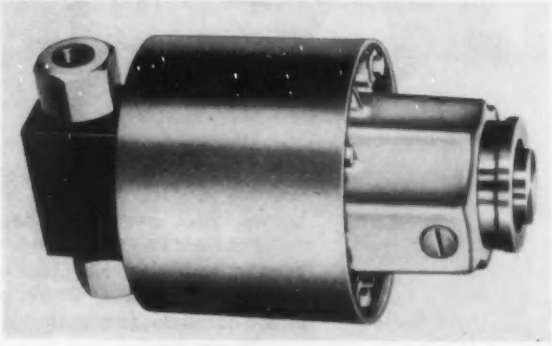
Kahm & Co., Inc., 541 Windsor St., Hartford, Conn.

Air-Operated Hydraulic Pump Delivers 30,000 Psi

Development of a new, air-operated hydraulic boost pump which features an automatic, pilot-operated air selector valve to eliminate stalling, operates on the principle of differential areas. The new pump, called the Model D-302 has a large air-driven piston, which drives a smaller fluid piston, which delivers a fluid volume at high pressure.

Design and construction of the unit permits either oil or water to be used for testing or powering. Models presently available have pressure outputs ranging from 0 to 30,000 psi when operating on 80 psi maximum air pressure. Both discharge and volume of fluid can be easily and accurately controlled. Fluid output capacities range from 2½ gpm at 1,000 psi to 8 cubic inches per minute at 30,000 psi.

Applications include: static and burst pressure testing of hose, cylinders, etc.; flow tests which require low flows at high pressures; and for fluid power for hydraulic presses and devices used in fixture clamping and pressing.



Southern Calif. Hydraulic Engineering Corp., 6318 South Central Ave., Los Angeles 1, Calif.

AN EXTRUDED RUBBER BASED SEALER with 100 percent solids content is applied in the form of a flexible rubber strip, and when heat cured, expands to form a positive, uniform gasket material between metal surfaces. Features are: sealing seams not uniform in width; special pressure application equipment unnecessary; no waste of material. Amount of volume increase depends on the time and temperature used, i.e., 15 min. cure at 350 F will cause swell of 125 percent. Minnesota Mining & Mfg. Co., 423 Piquette Ave., Detroit 2, Michigan.

CONTINUED ON PAGE 228

Sensational FOR PERFORMANCE...

WICHITA STANDARD Air-Tube DISC CLUTCH
SPECIAL VENTILATED Air-Tube DISC CLUTCHES
WICHITA LOW INERTIA Air-Tube DISC CLUTCH

WICHITA *Air-Tube* CLUTCHES

These three simple, compact, powerful, trouble-free Air-Tube friction clutches combine all the advantages inherent in air operation, such as: convenient remote control, small manual pressure required for full torque, smooth starting and quick disengagement.

They are engineered to give longer service at a lower operating cost because each requires very little maintenance. Many test runs of Wichita Clutches have exceeded 2½ million engagements and still no failures occurred. Such performance is proof of the sound engineering behind Wichita Clutches. Pick the Clutch *you* need for the job! *Call the nearest Wichita Engineer for complete detailed information.*

OTHER OUTSTANDING ADVANTAGES

- Safer Operation
- Cooler Running
- Minimum Slippage
- No Backlash
- Built in Standard and Low Inertia Types, All Positively Ventilated
- No Lubrication
- No Adjustments

WICHITA FOUNDRY & MACHINE CO., INC.
WICHITA FALLS, TEXAS, U.S.A.

WICHITA DISTRIBUTORS

Brehm-Lahner, Inc., Detroit, Michigan
L. H. Fremont, Cincinnati, Ohio
W. G. Kerr Company, Pittsburgh, Pa.
Smith-Keser & Co., (Main Office) West Hartford, Conn.
Smith-Keser & Co., Philadelphia 44, Pa.
Smith-Keser & Co., New York, N. Y.
Frank W. Yarline Co., Chicago, Ill.
Power Rig & Equipment Co., Inc., Long Beach, Calif.
Robert E. King Co., Cleveland, Ohio
John C. Borge, Okla. City, Okla.
Dominion Power Press Equipment, Ltd., Toronto, Canada.

Ad 6DN

Pressurizing Kit for Aircraft Electronic Systems

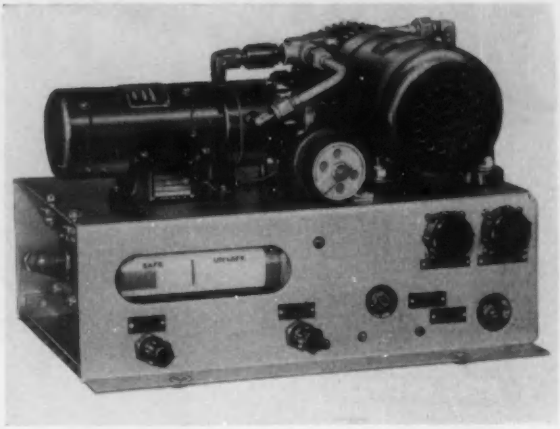
The principle application of this new unit, is the automatic control of air pressure in the radar antenna wave guide at the tail of one of the newest jet bombers. The object is to hold air pressure equivalent to sea-level pressure at altitudes of 50,000 feet and higher, which prevents electrical arcing in the electronic section. The pressurizing kit compensates for specified leakage of 63 cubic inches per minutes at altitude with a maximum of 25 percent running time.

Cil-free air pressure pumps, Air Force type MA-1 and MA-2, provide two-stage compression. Pumping in series lessens the differential pressure of each pump and accounts for the increased air capacity at higher altitude, not attainable with a single pump. The pumps are rotary, sliding vane type with the pumping element built integral with a 27 volt d-c motor.

Low total input current of 14 to 15 amperes is due to the low friction of the pump parts. No oil is used as thrust plates and blades are carbon-graphite self-lubricating composition. Friction is negligible as no shaft seals or packings are used. Manufacturing tolerances and materials permit normal starting and free running at —85 F. The motors are equipped with radio interference filters and are explosion proof type.

Inlet air to the oil-free pumps passes through a silica gel dehydrator, which is capable of supplying clean dry air under conditions of an ambient relative humidity of 95 percent. Thus, the radar unit is pressurized with air that is completely free from water and oil vapor. The rated capacity of the pressurizing kit is 200 cipm, 16.5 psia at 50,000 feet.

The kit is equipped with two air outlets for connection directly to the radar and to a remote control panel. Components of the kit are dehydrator, two-stage air pumps, check valves, isobaric relief valve, and adjustable absolute



pressure switch which maintains air pressure between 14.5 and 16.5 psia. For remote signal to the crew, an additional absolute pressure switch is set to open the signal circuit when pressure is below 13.5 psia.

The kit is designed for operation over long periods with little or no attention except for checking the condition of the indicating type silica gel, which is visible through the transparent tube.

Characteristic colors coincide with attached color card at 0, 20, 40, and 60 percent relative humidity. When color changes from blue to pink, the silica gel may be reactivated or the 9.6 ounces of desiccant may be replaced. Total weight of the pressurizing kit is 21.8 pounds.

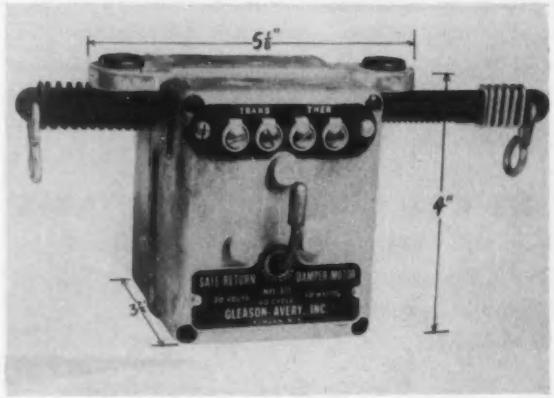
Lear Romec Division, Lear, Inc., Elyria, Ohio

Motor Geared for Straight-Line Action

To electrically actuate switches, levers, and other mechanical devices, this new motor assembly is equipped to convert power taken from the drive shaft of a high speed fractional horsepower induction motor into lateral motion. This is done through a rack that can be made to travel as much as 12 inches either left or right. The rack is returned to normal position by spring loading or by means of a counterweight when the circuit is de-energized.

Chief advantage claimed for the safe return unit is that it will handle heavier loads than solenoids or other devices for converting electrical energy into lateral motion. The unit, the "311," will lift approximately 25 pounds (direct pull) a distance of four inches in 30 seconds. It can be used to operate such devices as louvres, windows and other heavy mechanical contrivances that must be opened, shut or moved laterally either automatically or by remote control.

The "311", according to the manufacturer, is available for 20 v or higher applications on 25, 50 or 60 cycle current.

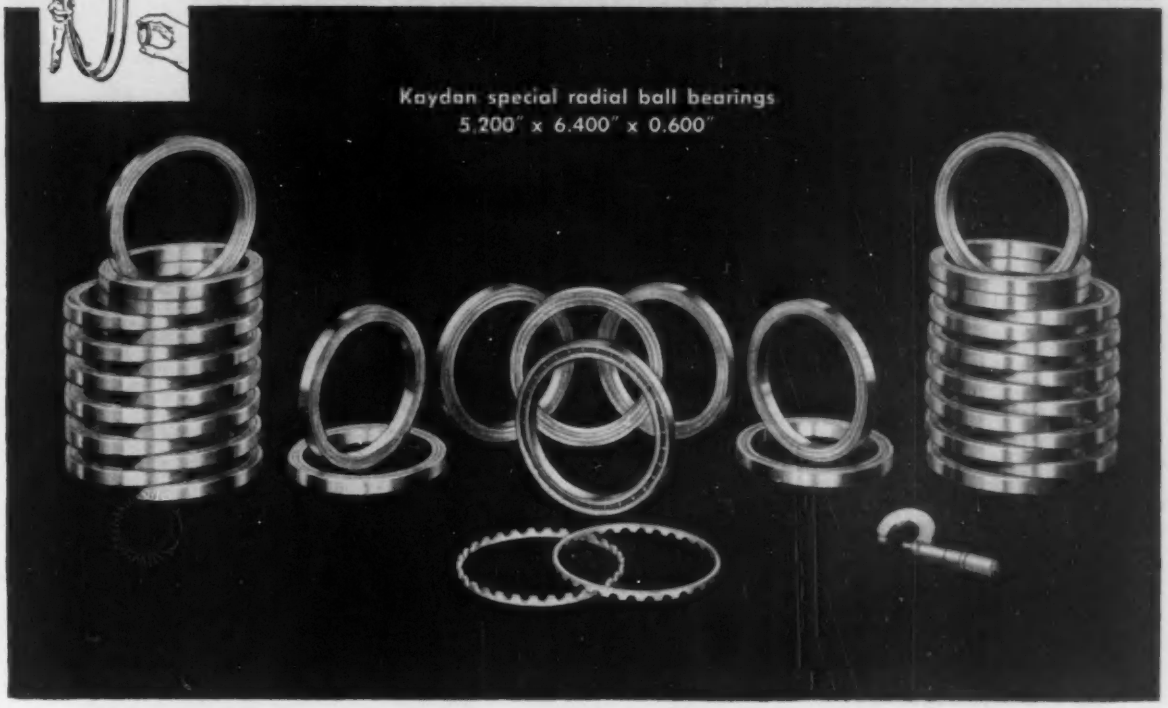


Gleason Avery, Inc., Auburn, N. Y.

CONTINUED ON PAGE 230

Contact KAYDON of Muskegon

FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER

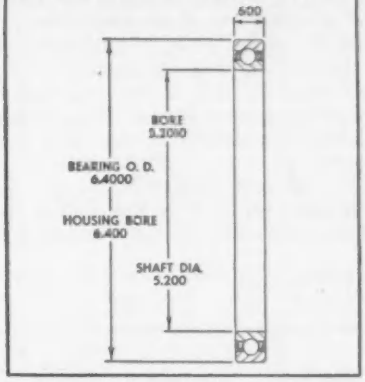


Special radial ball bearings— industrial jewels produced by Kaydon

Unusual thin-section, high-precision bearings like these are standard products of the **KAYDON** Engineering Corporation. **KAYDON** designers and engineers have come to regard "near impossible" assignments as everyday routine.

That's why more and more manufacturers call in **KAYDON** on problems involving special bearings. They've happily found . . . that to build the special bearings they need . . . **KAYDON** has the unmatched experience and the facilities necessary to handle the job on an economical basis.

Details of thin section bearing shown above—



KAYDON Types of Standard and Special Bearings:
Spherical Roller • Taper Roller • Ball Radial • Ball Thrust
• Roller Radial • Roller Thrust • Bi-Angular Bearings

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

PRECISION BALL AND ROLLER BEARINGS

New Engine-Generator Control

Two new features of a new engine-generator control that may be used with diesel or gasoline driven sets, and which is also classed as demand start, load start, fully automatic lamp start control are:

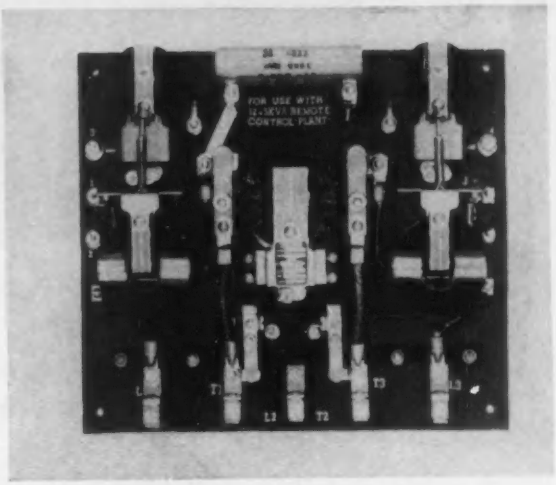
(1) The Load Itself Starts the Engine. The design of the new control is such that when any load is turned on—lights, motor, heating unit or any other load—the power unit automatically starts. There is no master switch to throw. When the loads have been turned off, the plant will automatically stop.

(2) Built-in protection to prevent stalling when the load is applied. The load is automatically held off until proper voltage and frequency are delivered. Only then is the load connected.

Other features include: no delicate parts or critical relay adjustments; pilot contacts for starting contactor; magnetic grounding; battery charging; no residual magnetism sticking on relays.

Controls for 3-wire plants can be used with grounded neutral stand-by systems. Present ratings range from 2 to 18.75 kva. (open or enclosed 3; minimum starting loads from 60 to 100 watts for 2 or 3 wire generators.

Operation—When the load is connected, the relay coil CR is energized through a normally closed contactor. An LR contact on the engine starting control closes the remote control circuit which starts the plant. The line contactor LC (normally open contact) will not close until the generator is up to speed and frequency. When this occurs, the load is connected to the generator. At the same time, relay coil CR is disconnected from the battery.



Automatic Switch Company, 391 Lakeside Ave., Orange, N. J.

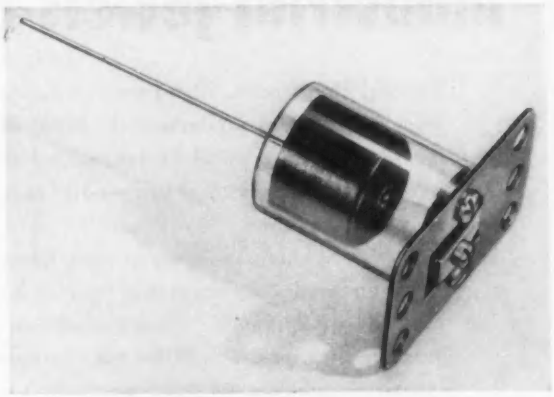
Air-Damp Dashpot Used As System Stabilizer

A new precision air-damp dashpot for use as a system stabilizer in control mechanisms and switchgear, is now available. Able to maintain its calibration, this small, compact unit, weighs less than half an ounce.

The dashpot eliminates roundabout solutions for mechanical damping and shock absorption. Possessing the reliability of springs, it can be used where simple airvanes are inadequate, and magnetic damping too heavy.

The dashpot is made of low expansion glass cylinders and graphitized-carbon pistons, fitted to tolerances closer than 0.002 inch. It will operate from —75 to 150 C.

Damping constant is adjustable up to 0.06 pound-sec/inch; maximum tension force is 4 pounds at sea level; compression force is limited only by the strength of the materials used. Sliding friction is less than 0.2.



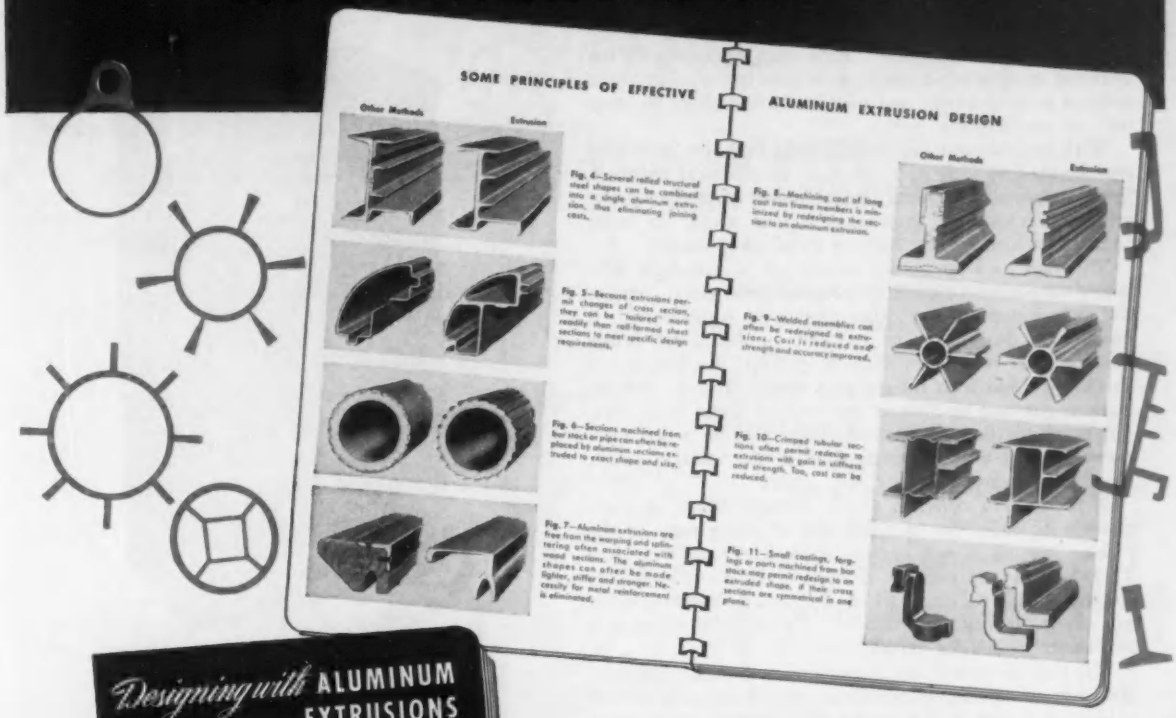
Electric Regulator Corporation, Norwalk, Conn.

A NEW FIVE-PIECE TEMPLATE set provides a uniform, positive system for determining dimensions of lines and angles without use of involved projection. Curves, radii, and ellipses are determined by the templates. The templates enable the draftsman to draw views of an object from any angle. Charles Bruning Co., 4700 Montrose Ave., Chicago 41, Ill.

GLASS-BRAIDED LEAD WIRE has been developed for electronic and electrical components operating at temperatures from —55 to + 200 C. Called Temp-clad, the primary insulation is Teflon, with good dielectric strength, low power factor, and high insulation resistance. Suitable for a-c potentials to 600 v rms. Hitemp Wires Inc., 26 Windsor Ave., Mineola, L. I., N. Y.

CONTINUED ON PAGE 232

How to Take Advantage of Aluminum Extrusions


SOME PRINCIPLES OF EFFECTIVE ALUMINUM EXTRUSION DESIGN
Other Methods
Extrusion
Fig. 4—Several rolled structural steel shapes can be combined into a single aluminum extrusion, thus eliminating joining costs.
Fig. 5—Because extrusions permit changes of cross section, they can be "tailored" more readily than roll-formed sheet sections to meet specific design requirements.
Fig. 6—Sections machined from bar stock or pipe can often be replaced by aluminum sections extruded to exact shape and size.
Fig. 7—Aluminum extrusions are free from the warping and splintering often associated with wood sections. The aluminum shapes can often be made lighter, stiffer and stronger. Necessity for metal reinforcement is eliminated.
Fig. 8—Machining cost of long cast iron frame members is minimized by redesigning the section to an aluminum extrusion.
Fig. 9—Welded assemblies can often be redesigned as extrusions. Cost is reduced and strength and accuracy improved.
Fig. 10—Crimped tubular sections often permit redesign to extrusions with gain in stiffness and strength, too, cost can be reduced.
Fig. 11—Small castings, forgings or parts machined from bar stock may permit redesign to an extruded shape, if their cross sections are symmetrical in one plane.

138 Page Reynolds Handbook Shows How to Increase Design Efficiency ...Lower Production Costs

Limitations of rolled structural shapes, formed sheet sections and machined, cast or welded parts are soon forgotten when you thumb through the authoritative handbook, "Designing With Aluminum Extrusions." The many important advantages obtainable with extrusions are shown in the above pages reproduced from the book.

Extrusion dies are inexpensive, so special shapes that use the metal most efficiently can be produced economically. The handbook shows how . . . with 126 illustrations and chapters on Features of Aluminum Extrusions; Examples of Effective Extrusion Design; Manufacturing Possibilities; Shape Design from Manufacturing Standpoint; Structural Design Considerations; Finishes; Cost Factors and a wealth of other essential data.

Your free copy of "Designing With Aluminum Extrusions" is available, along with a complete index of other helpful Reynolds literature, when requested on a business letterhead. Simply write to Reynolds Metals Company, 2561 South Third Street, Louisville 1, Kentucky.

See "Mister Peepers" Sundays, NBC-TV. Consult local listings for time and station.

REYNOLDS ALUMINUM

MODERN DESIGN HAS ALUMINUM IN MIND

Proximity Pick-up Impulse Generation

A new proximity pick-up impulse generator has been designed as a low speed complement to a magnetic pick-up developed by the company. As a high frequency carrier operated transducer, it works on a principle similar to the military mine detector, and may be excited either by magnetic or non-magnetic metals.

With suitable auxiliary equipment, this new proximity may be used to indicate mechanical or electrical counting, linear or angular position, rate of travel, sequence timing, vibration frequency, angular or linear speed, or other functions which involve moving metal components.

This new pick-up system consists of a transducer connected by a ten-foot cable to a control unit which contains the power supply and other electronic components. It produces a d-c voltage of constant amplitude when any metallic mass is brought near the pickup. No mechanical contact is made with the exciting metal. The d-c voltage remains constant as long as the exciting metal is in close proximity to the pick-up and drops to zero when it is removed. The rise and delay time of the voltage is fast, thereby producing a definite snap action.

It produces a constant output voltage which is independent of either the speed of the actuating mass or the pick-up spacing. It will operate at any rate from 0 to over 12,000 times per minute. Control units have knockouts for use with ½ in. electrical conduit and holes for mounting screws. It may be used either as a portable unit or as a permanently mounted fixture.

The pick-up control box is available in two styles. Model 4901 has a 4-volt d-c output. Model 4091R is equipped with a built-in 5 amp 115 v single pole double throw relay. This relay will operate mechanical counters at rates up to 600 a minute. It may also be made to turn on or off any electrical device for controlling position, limits or quantity. It may be adapted to sequence control where the next operation is started by the arrival of the work at a position.

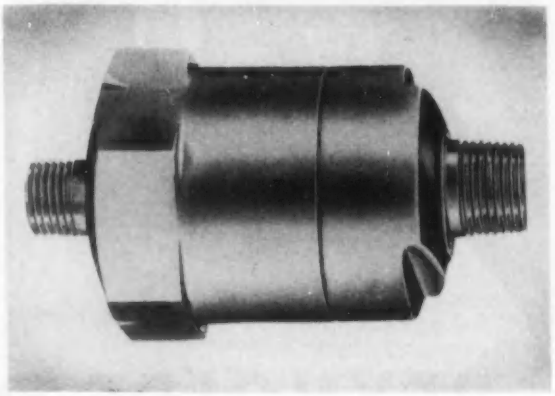
Electro Products Lab., Inc., 4501 N. Ravenswood Ave., Chicago 40, Ill.

Low Pressure Automatic Drain Unit For Air Systems

Compressed air systems may now be drained of condensation automatically in the course of closing down between shifts or overnight. A new low pressure unit drains air lines, after coolers, and the like, and opens when pressure drops past 10 lb, allowing all moisture to be blown out before line pressure reaches zero.

When pressure begins to build up again in the system, the drain unit closes, or resets, as the pressure rises past 10 pounds. It is so designed that four hundred percent more pressure is exerted against the discharge valve than is normally achieved for the area of the valve seat. This assures a positive seal even at low pressure. In addition, a second o-ring seal makes two failures necessary before any leak in the unit can occur.

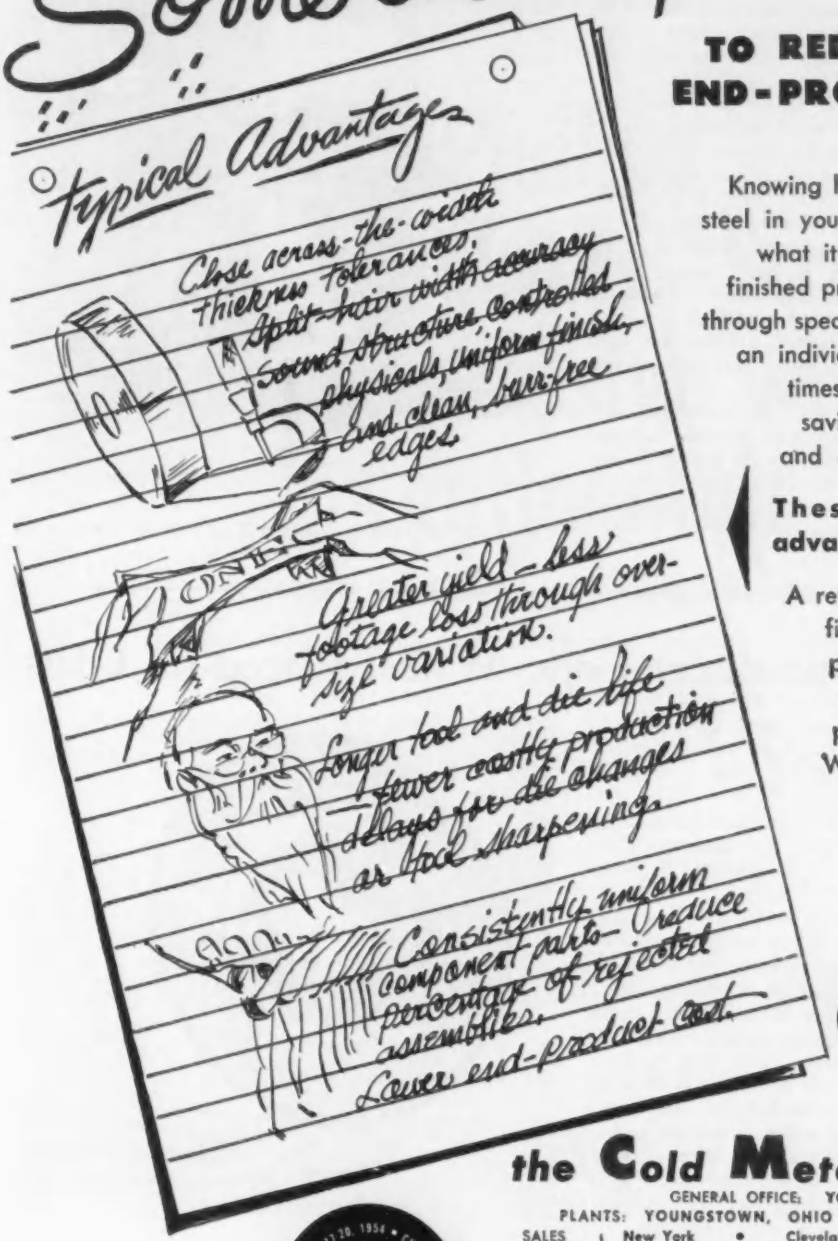
While 10 lb is the standard operating pressure, these units can be built to operate at lower or higher pressures. Whatever the operating pressure, resetting occurs at pressures only fractionally higher. Thus, it is possible to blow lines or tanks clean without unnecessary loss of air.



Wilkerson Corp., 3387 S. Platte R. Dr., Englewood, Colo

CONTINUED ON PAGE 234

CMP
COLD ROLLED STRIP STEEL OFFERS
Some Wonderful Ways
TO REDUCE END-PRODUCT COSTS


Typical Advantages
Close across-the-width thickness tolerances.
Split-hair width accuracy
Sound structure, controlled physicals, uniform finish,
End, clean, burr-free edges.
Greater yield—less footage loss through over-size variation.
Longer tool and die life
—fewer costly production delays for die changes or tool sharpenings.
Consistently uniform component parts—reduce percentage of rejected assemblies.
Lower end-product cost.

Knowing how you use cold rolled strip steel in your fabricating operations and what it is called upon to do in the finished product . . . CMP can develop through special processing for those needs an individual strip product that many times makes possible important savings in fabricating, assembly and end-product costs.

These are some of the advantages you can count on

A review of your strip steel specifications in terms of what CMP precision strip steel can do for your product betterment may prove mutually advantageous. We will welcome your invitation to call.

PRECISION COLD ROLLED CMP STRIP STEEL

the Cold Metal Products co.

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PLANTS: YOUNGSTOWN, OHIO AND INDIANAPOLIS, INDIANA
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THE KENILWORTH STEEL CO., 750 Boulevard, Kenilworth, New Jersey
Phones: N. Y., COrtlandt 7-2427; N. J., UNionville 2-6900

PRECISION STEEL WAREHOUSE, INC.
4425 W. Kinzie, Chicago — Phone : COlumbus 1-2700

See us at Booths 707 and 711

MAY 17-20, 1954 • CHICAGO
BASIC MATERIALS EXPOSITION
THE PRODUCT DEVELOPMENT SHOW

Smoother Running, Quieter Motor-Compressor

A new twin-cylinder type welded, hermetic motor compressor for window air conditioners will—says the manufacturer—run more smoothly and have a lower noise level than will single-cylinder models.

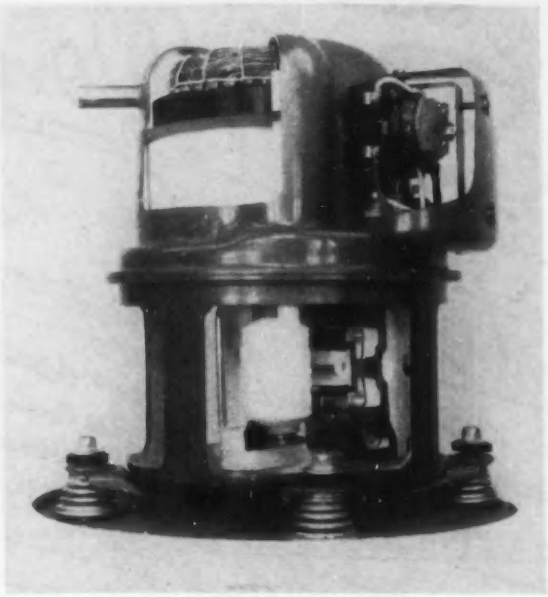
All rods and bearings are made of solid bronze for longer wears. A sound, one-piece casting insures positive alignment of motor and bearings. A heavy-duty, high power factor motor is used.

A cork alignment ring controls the air gap surrounding the motor to reduce noise, yet keeps the motor close to the shell permitting fast heat transfer to overload for positive protection. Motor starting relays are current-type on the ½ hp and light ¾ hp, potential-type on the heavy ¾ hp and one hp. A highly sensitive, 3-terminal type overload protector is furnished. Counter-balanced crankshaft results in far less vibration.

Suction and discharge mufflers are built in. The large suction muffler has low pressure drop, contributing to high efficiency. Suction and discharge reeds are Swedish steel. The oil pump has no moving parts and will operate efficiently when rotating in either direction.

It is claimed that the use of F-12 in these motor-compressors results in up to 75 F lower temperature in motor windings, crank-case, oil and discharge side than to be had with motor-compressors using F-22.

It is said that many of these engineering features fill specific requirements of air conditioners.



Copeland Refrigeration, Clinton & Thomas Streets, Sidney, Ohio

Pattern for Transducer Code Wheel Placed on Glass

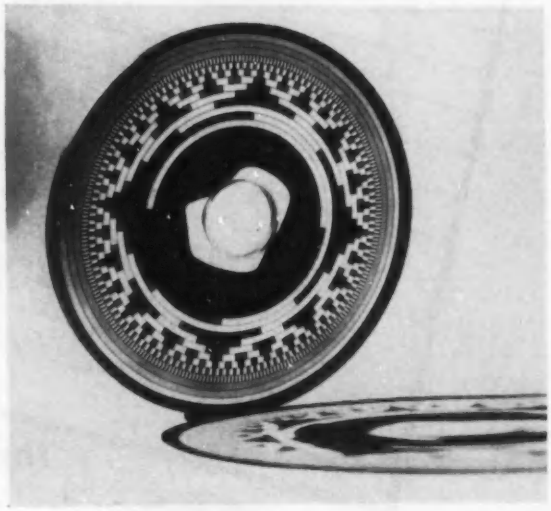
The pattern for a digital code wheel, containing 13 concentric rings of alternating opaque and transparent sectors, has been placed on glass. The glass is 5½ in. in diameter.

The number of sectors per zone increases by doubling to 2^{12}, or to 4096 in the outer zone. The divisions in the outer ring were made less than 0.1 in. long and 0.004 in. wide.

The code wheel will be used in a binary code transducer system. The system will supply data by rotational position of an instrument shaft to digital computers used in various military applications. This new method of marking blanks by photographic methods is said to have unlimited possibilities in reproduction of irregular patterns spaced at closely controlled regular intervals. This will supplant previously attempted methods with conventional dividing equipment. The manufacturer claims that the code wheel pattern on glass will make it possible to encode analog data more accurately and simply than by other methods.

In actual use in encoding, one of the glass code wheels is rigidly mounted on an instrument shaft and light is passed through the wheel and a slit to phototransistors.

Computers used with the code wheel are based on a binary, rather than a decimal system. In any position, the arrangement is opaque and clear sectors in the annular zones represent a specific binary number. It is possible to read a total of 8192 number codes, which enable determination of accuracy of shaft position to approximately 2.5 minutes arc. As a prevention against ambiguity, the so-called Gray code—a special binary system—is used.



W. & L. E. Gurley Co., Station Plaza, Troy, N. Y.

CONTINUED ON PAGE 236

HERE'S PROOF: You can always count on Continental for every fastener need!

Phillips "Bits—Holders—Screws" are Exclusive with Continental!

...they can cut your production costs

Continental is the only manufacturer producing this outstanding Phillips fastening combination—bits, holders, and screws. Their development has finally made power driving really practical, even on finished parts.

They have cut fastening costs as much as 50% and Continental's HY-PRO-Phillips bits average 2 to 4 times longer life than any other . . . one actually drove over 1,000,000 screws. Yes, it's another Continental exclusive in an outstanding record of 50 years in business.

Put your fastening needs in experienced hands. Call direct today or contact your local distributor. Continental can help cut your production costs.

Manufacturers of HOLTITE Fastenings

CONTINENTAL SCREW COMPANY INC. 1904

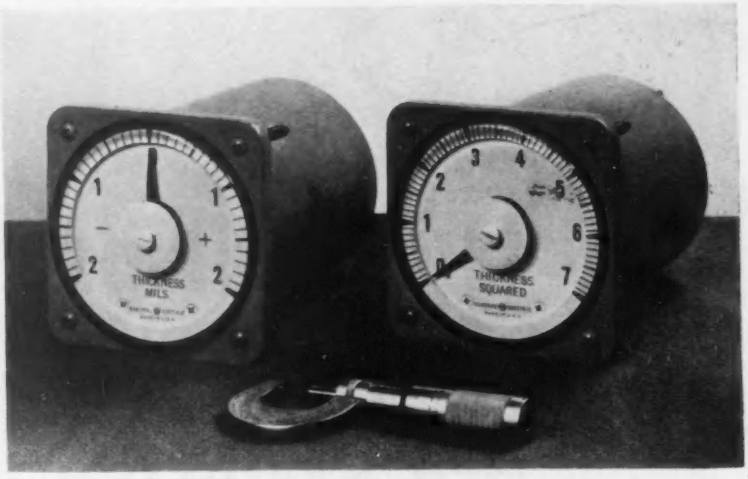
50th Anniversary

CONTINENTAL SCREW COMPANY

New Bedford, Mass., U. S. A.

Integrating Instruments For Quality Control

Designed for the solution of quality control problems that might be met by producers of yarn, wire, strip metals, photo film, rope, plastics and similar products in continuing moving processes, two new integrating instruments will—according to their manufacturer—"reduce laborious statistical analysis to a simple slide rule calculation."



The instruments, one current-integrating, left, the other current-squared integrating, right, have been specifically developed for use in the quality control of textile fibers and permit rapid determination of the average thickness and standard deviation of tested samples. They differ from conventional indicating instruments in that they contain no control springs and have a special mechanism that provides a high degree of damping.

When current ceases to pass through the coils, the instruments' pointers stop instantly thus affording unusually accurate readings. Since the lead-in spirals contain no appreciable torque, special control circuits are furnished to reset the instrument pointers to zero.

The current integrating instrument has a permanent-magnet moving-coil driving mechanism. The speed of its pointer at any instant is proportional to the current going through the coil at that instant. Rated from —85 to +85 milliampere-seconds, the instrument has an accuracy of plus or minus two percent of full scale for integrating random-varying currents lasting over a period of two minutes. The device responds adequately to instantaneous current values that are as low as 0.03 milliamperes and to peaks as high as 6 milliamperes.

The current-squared integrating instrument has a dyanometer-type driving mechanism. The speed of its pointer at any instant is proportional to the square of the current passing through it at that instant. Its accuracy rating is plus or minus three percent for integrating ordinary random-varying signals lasting over a period of two minutes, and it will respond to instantaneous current values ranging from 1.5 to 30 milliamperes.

General Electric Co., Schenectady 5, N. Y.

Universal Counter and Timer

This new universal counter and timer is capable of measuring and indicating time intervals from 3 microseconds to 1,000,000 seconds with accuracy to ±1 microsecond. And it can measure and indicate frequencies from 0 cycles to one megacycle, and periods of frequency from 0 cps upwards with an accuracy of ± microsecond.

The unit is direct reading, can operate as a straightforward electronic counter at rates up to 1,000,000 cps.

It offers automatic operation with display from 0.2 to 5 seconds and manual operation with infinite display; scanning to any multiple of one or 10 seconds; and a direct test of all time base frequencies.

Berkeley Div., Beckman Instruments, Inc., Richmond, Calif.

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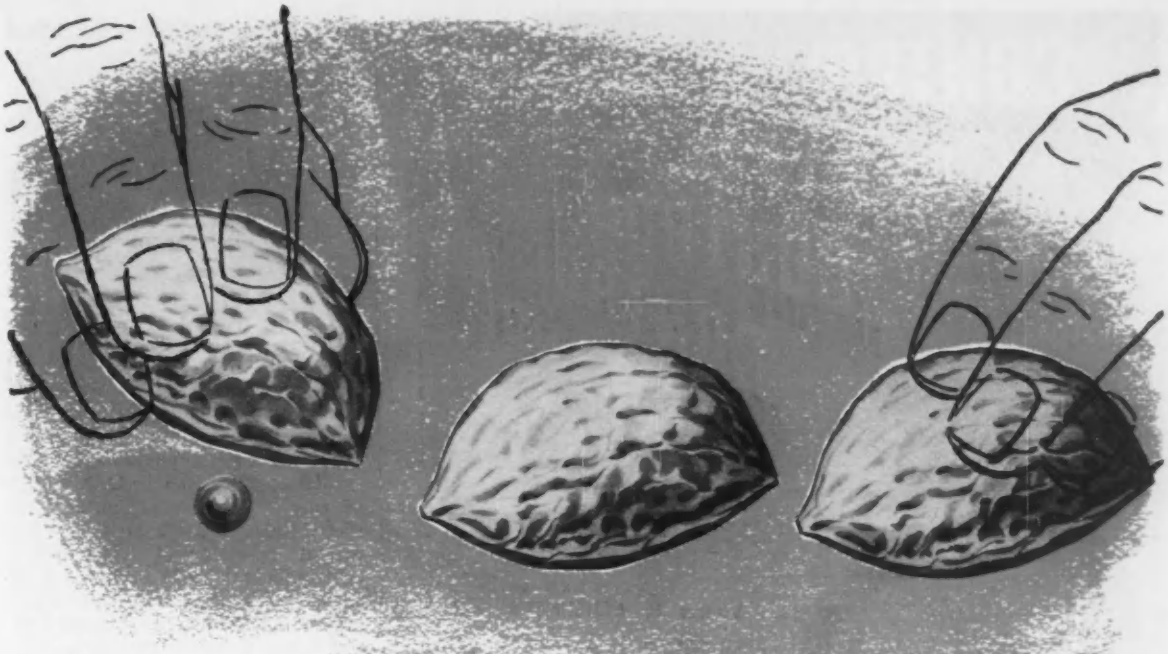

THEY MAY LOOK ALIKE

...but there's a big difference underneath

And it's the same way in buying carbon or alloy steel tubing. Lots of it looks very much like OSTUCO . . . but underneath it all there are these advantages that save you money:

OSTUCO provides a single source service . . . complete manufacturing, fabricating and forging operations under one roof mean one purchase order takes care of all details. And you can depend on deliveries as promised. OSTUCO'S flexibility assures the same efficiency and economy in both large or small production runs. OSTUCO'S quality control maintains uniformity of structure from raw materials to finished product.

The complete story as outlined in an informative booklet, "OSTUCO Tubing," is yours for the asking. Or better still—for conclusive proof—send us your blueprints for prompt quotation.

OSTUCO SHELBY, OHIO

OSTUCO TUBING

SEAMLESS AND ELECTRIC WELDED STEEL TUBING —Fabricating and Forging

OHIO SEAMLESS TUBE DIVISION
of Copperweld Steel Company • **SHELBY, OHIO**
Birthplace of the Seamless Steel Tube Industry in America

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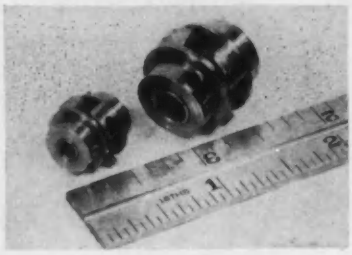
Visitors to ACUSHNET'S modern plant are particularly impressed by the scope and perfection of our Quality Control System. This rigid laboratory control at each stage of production is a positive safeguard in maintaining the precision for which Acushnet molded rubber parts are so widely known.

As precision starts at the expertly designed mold, control at this point is vitally important. Heats from all molds are sectionalized at least once a day and all essential dimensions of the product are measured. In addition, every two hours a full heat from every mold is checked, and certain basic dimensions selected for control purposes are checked. Particularly critical products are checked even more frequently and thoroughly.

If your molded rubber parts call for controlled precision, you can call on ACUSHNET to meet your strictest specifications — to your complete satisfaction. Send for the "Acushnet Rubber Handbook", a comprehensive rubber data reference.

Acushnet
PROCESS COMPANY

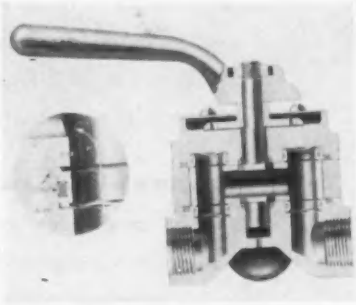
Address all communications to 768 Belleville Ave., New Bedford, Mass.



Miniature Coupling

Pictured are two of the smallest of a new line of precision shaft couplings for rotating components in computer, servo and control mechanisms. The smaller coupling, 0.5 in O.D. by 0.5 in. long for up to 0.1875 in. diameter shafts allows ±0.020 in. by ± five percent misalignment. The larger, 0.75 in. O.D. by 0.75 in. long for up to 0.375 in. diameter shafts, allows ±0.030 in. by ± five percent misalignment. Backlash tolerances meet the most rigid requirements, says the manufacturer, and larger sizes are available.

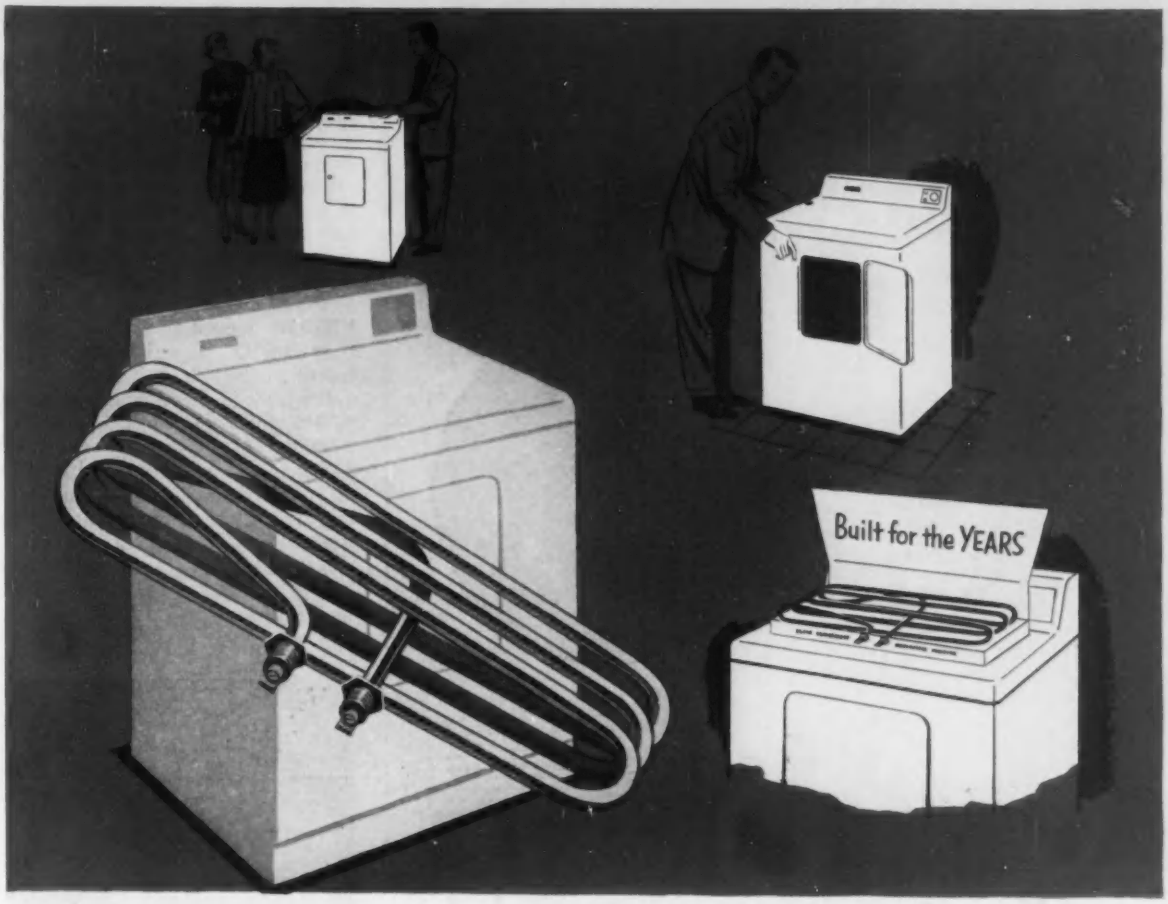
Ward Associates, 2926 Balboa Ave., San Diego 9, Calif.



High-Pressure "Balanced" Selector Valve

Pressures up to 6,000 psi can easily be handled by this new selector valve, says the manufacturer. The valve consists of a body, ported as desired, which encases a disk having internal flow passages. As the disk is revolved to produce flow through the ports, sealing rings take effect and eliminate cross leakage within the valve.

A 6 in. handle is more than adequate for easy turning of the disk of the 1 in. size under 6,000 psi pressure. This low turning torque is obtained by two design features, based on the hydraulic principle that fluids under pressure exert force equally in all directions. First, fluid reaches both sides of the rotary disk causing it to "float"



For FASTER, EASIER SELLING of Clothes Dryers

equip with TK® Rod-type heating units

That *competitive advantage* you are seeking this next year could well be the use of TK Rod-type heating elements. Granted, they'll probably cost more—and this fact may deter some manufacturers from adopting them. But think of the *sales pluses* you get—for as little as 40 to 50 cents added to the cost of your product.

Your dealers (and *their* customers, too) will sense the extra value at a glance. Ruggedly built, compact, free from the hazards of lint, moisture and corrosion, TK Rod-type units provide the ultimate in electric heating. Best of all, they will last longer, *years longer*—an important point when householders are investing hundreds of dollars in an appliance.

TK Units for DISHWASHERS, Too!

Sturdily built for long service, quickly responsive in operation, *TK Immersion Units* help sell your product . . . help to keep it sold thereafter. Write today for further details, also for any help you may need in designing the heating element.

TK FERRO

FERROD MFG. COMPANY

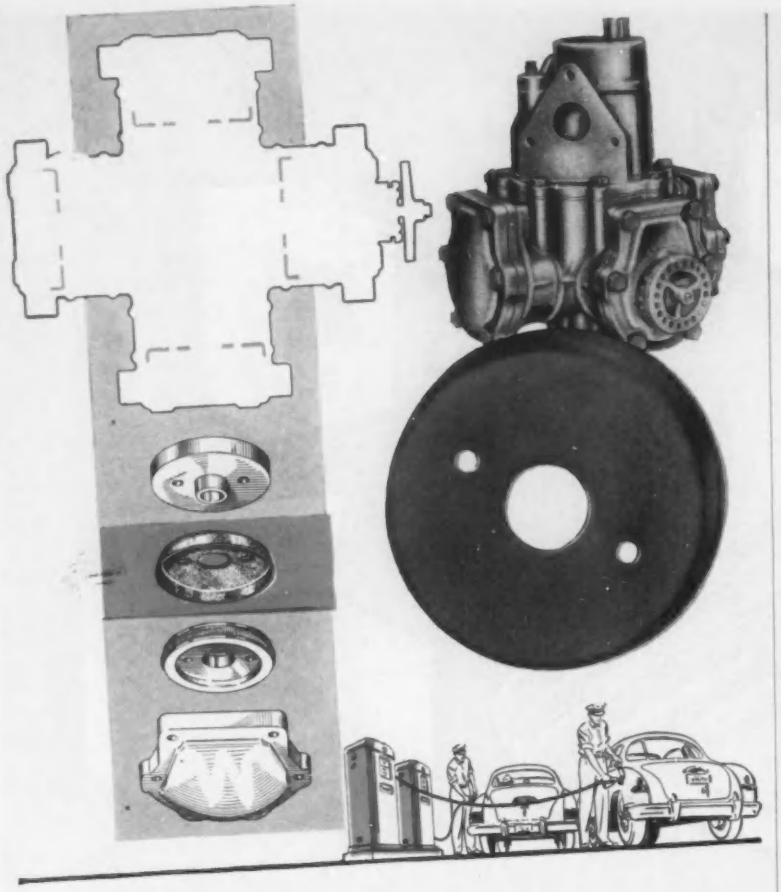
A Subsidiary of Ferro Corporation

605 N. RIVER ST. • BATAVIA, ILL. • PHONE 6240

in its chamber and thus eliminating directional pressure and the need for thrust bearings. Second, sealing rings are designed with a larger area on the bottom of the seal than on the surface toward the disk, thus positive contact of the seal is assured, regardless of flow direction or pressure. Back pressure will not unseat the seals. There is an equal number of seals on each side of the disk (two at each port), again balancing pressures. Highly finished parts and "O" rings eliminate internal leakage.

It is made in sizes $\frac{3}{8}$ in. to one in. for 0-2000 psi, and $\frac{1}{8}$ in. to one in. for 0-6000 psi, for most services; for air and gas service, 0-1000 and 0-3000 psi, respectively. Three types of portings are available—side or bottom pipe tap, and sub-plate mounting.

Republic Manufacturing Co., 1930 West 77th St., Cleveland 2, Ohio



How G&K-INTERNATIONAL helps Gilbarco Pumps meter gasoline with "Split drop" accuracy

The Gilbarco four-piston positive displacement meter is as nearly frictionless as any mechanism can be. You can spin it by blowing your breath into its inlet port. Yet the four pistons operate in positive leak-proof contact with the cylinder walls.

The problem is solved with four leather cup packings, coated inside to prevent the penetration of the gasoline. The cups must not vary in any dimension more than .0025 inch – a real achievement when working with leather.

Meeting *required accuracy* and *scheduled deliveries* are two *"musts"* at G&K-INTERNATIONAL. That's why you, like Gilbert & Barker Manufacturing Company, can depend upon this source for your packings in modern leather Cups, Flanges, U's, V's and Oil Seals; and in standard or special synthetic rubber packings of all types, including O-Rings.

Write for G&K-INTERNATIONAL Catalog and Manual 201-A. 60 pages of up-to-date data including latest JIC and officially recommended sizes for all types of packings.

G&K- INTERNATIONAL *Packings*

GRATON AND KNIGHT

LEATHER — SYNTHETIC RUBBER

GRATON & KNIGHT COMPANY, Worcester, Massachusetts
INTERNATIONAL PACKINGS CORPORATION, Bristol, N. H.

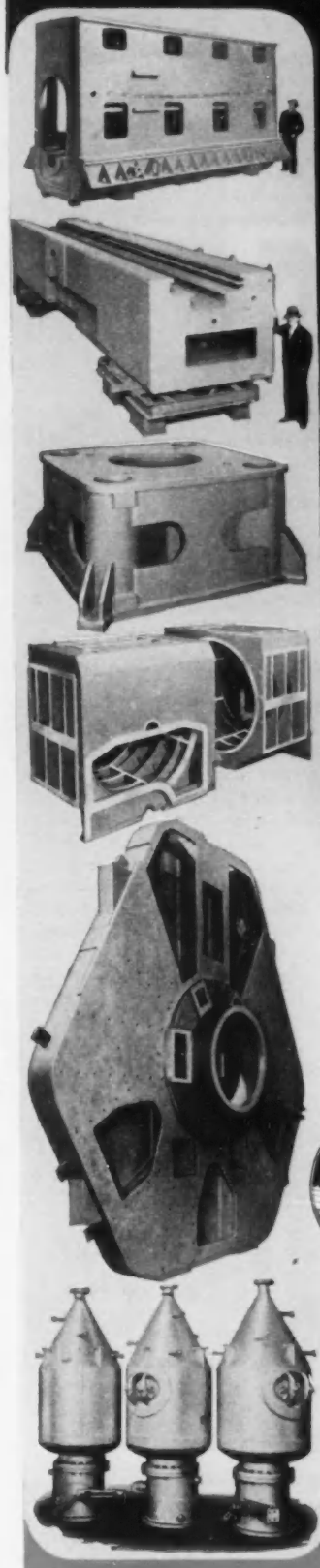
P-3

Testing the Softness of Foam Rubber

A hand tester for the measurement of hardness or resiliency of foam and sponge rubbers, as well as other soft elastomers, will—according to the manufacturer—fill an urgent need in industry and the laboratory. A measurement is made by simply placing the instrument on the material to be measured and pressing it against the material so that the base is flush with material surface. This permits the indentor to give a direct reading on the scale of the dial. Several readings may be made within a few seconds. Accurate readings are predicated on the specimen being at least $\frac{3}{4}$ in. thick. Thin materials should be stacked to the required thickness. Measurements are fully reproducible and can be made practically instantaneously.

Cellular rubbers of the sponge and foam type have been, in general, indicated as "soft," "medium," and "firm"

Steel-Weld FABRICATION



Use WELDED STEEL for Greater Strength with Less Weight!

The two Steel-Weld Fabricated propeller and engine mount sections for wind tunnels, illustrated above, and the parts and assemblies shown at the left, are typical of thousands of Steel-Weld Fabricated units produced and machined by Mahon for hundreds of manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment. Perhaps you, too, should discuss this service with a Mahon engineer? If you require parts or assemblies including large, heavy pieces, where time and pattern costs are a consideration, Steel-Weld Fabrication may be the answer. You can turn to Mahon with confidence . . . personnel and facilities are available within the Mahon plant to do the complete job from drawing board to finished machining. You will find in the Mahon organization a unique source with complete ultramodern fabricating, machining and handling facilities to cope with any type of work regardless of size or weight . . . a source where skillful designing and advanced fabricating technique are supplemented by craftsmanship which assures a smoother, finer appearing job embodying every advantage of Steel-Weld Fabrication. See Mahon's Insert in Sweet's Product Design File, or have a Mahon engineer call and give you complete information.

THE R. C. MAHON COMPANY
DETROIT 34, MICHIGAN

Engineers and Fabricators of Steel in Any Form for Any Purpose

MAHON

...of cutting production costs!

THESE HANDS are about to *preplace* a ring of EASY-FLO low-temperature silver brazing alloy on a machined part preparatory to heating and joining the part to another.

And how does this simple act cut production costs?
Well, here's how:

Preplacing EASY-FLO is the key factor in a method of joining metals that reduces brazing to push-button simplicity and assures a steady stream of soundly brazed parts—with easily trained labor doing the whole job.

The reduction in time and labor — plus the savings in heat due to EASY-FLO's low brazing temperature—bring brazing costs down to surprisingly low figures.

Will preplacing cut your production costs?

You can find out very easily. One of our field engineers will look over your metal joining work and give you the answer – entirely without obligation. Just write and say when you'd like him to call.

WELDING SHOW BUFFALO

VISIT OUR BOOTH SEE the preplacement method in action on an actual production brazing setup. Also a cemented carbide tip brazing demonstration. Examine the many interesting examples of silver brazed parts from many industries. Talk over your metal joining problems with our brazing engineers who will be there for that purpose.

For the full facts in print, write for a copy of Bulletin 20

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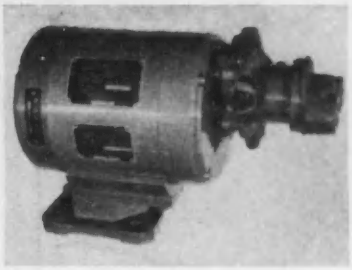
(as regards their resilient properties). The tester indicates these three ranges of hardness and further divides the ranges into smaller increments so that much closer and more accurate tolerances may be determined.

The instrument weighs 6 ounces, is $2\frac{1}{4}$ in. wide by $1\frac{1}{8}$ in. deep and $3\frac{3}{8}$ in. high.

Pacific Transducer Corps., 11921 West Pico Blvd., Los Angeles 64, Calif.

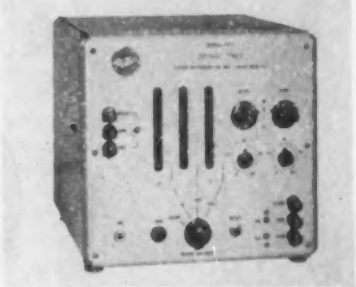


Aircraft High Pressure Hydraulic Pump

Now available for aircraft application is a new high pressure, motor driven hydraulic pump requiring 25 percent less amperage and offering a weight reduction of over 30 percent.

Specifications are: rated pressure, 3,000 psi; proof pressure, 3,750 psi; rated capacity, 0.5 gpm; ambient temperature range, sea level to 60,000 ft; fluid, aircraft hydraulic MIL-0-5606; electric motor, 200 v a-c, 400 cycles, 3 phase; current drain, 9 amp max at rated pressure and voltage; dimensions, length $8\frac{3}{4}$ in., height $5\frac{5}{8}$ in., width 4 inches.

General Metals Corp., Adel Div., 10777 Van Owen St., Burbank, Calif.



Measuring Short Time Intervals

The general purpose precision timer shown here has been designed for industrial as well as laboratory use and comes in three ranges: 0.01 to 9.99

Specify

GITS *Unit* SEAL

Result:

Economy

"Economy . . . counts not in savings but in selection." —*Edmund Burke*

Economy through Efficiency

Gits Unit Seal proves itself in dependable performance over a wide range of operating conditions—including extra-high speed, heat and pressure applications. Operation at peak efficiency always means dollars-and-cents savings.

Economy through Adaptability and Versatility

Gits Unit Seal fits many applications as a standardized item actually carried in stock. You harness the savings of mass production to your own specific needs. Gits Unit Seal already has wide application in the following fields: Washing Machines, Disposal Units, Gear Motors, Speed Reducers, Aircraft Turbine Pumps, Accessory Drive Units, Jet Propulsion Units, Electrical Power Equipment, Automotive Accessories, Business Machines, Standard and Special Machine Tools.

Economy through Long Life

Gits Unit Seal is designed for maximum life in any recommended application. Here's the real "proof of the pudding" in saving money.

Write Today For FREE Illustrated Brochure, or send us your seal problem. Our experienced engineering staff is at your service.

*Cartridge Seal . . . requiring only 25% more space than lip-type seals.

GITS BROS. MFG. CO.

1838 S. Kilbourn Avenue — Chicago 23, Illinois

SHOCK, VIBRATION and NOISE

DO YOU WANT Complete DATA?

CATALOG 523-A. Air-damped Barrymounts for shock and vibration protection of military airborne equipment.

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BULLETIN 533. Medium-impact shock machine Type 150-400 VD, for qualification and acceptance shock tests up to 77g.

BULLETIN 534. Series M44 ALL-METL vibration isolators and Series TOMA mounting bases, for military airborne equipment under extreme operating conditions.

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BULLETIN 537. Series 262/633 vibration isolators, for isolating vibration and noise caused by medium-speed motors or motor-driven machinery.

BULLETIN 538. Series 670/297 shock and vibration isolators, for isolating shock caused by impact-type machines, and vibration and noise caused by heavy rotating or reciprocating machines.

Here are complete engineering data, application information, and pointers to profits in every field of shock and vibration isolation. Write TODAY for your free copies of the ones *you* need.

THE **BARRY** CORP.

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SALES REPRESENTATIVES IN

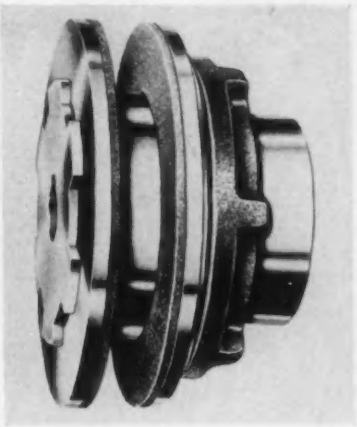
Atlanta Baltimore Chicago Cleveland Dallas Dayton Detroit Los Angeles Minneapolis New York Philadelphia Phoenix Rochester St. Louis San Francisco Seattle Toronto Washington

msec, 0.1 to 99.9 msec, and 1 to 999 msec. The instrument also serves as a high-speed totalizing counter with a count capacity of 999, and as a secondary frequency standard with outputs of 100 kc, 10 kc, 1 kc, 100 cps, 10 cps, and 1 cps.

In making a time-interval measurement, three electronic decades count the number of time-base pulses occuring during the unknown interval. A choice of three different time-base frequencies is provided; 100 kc, 10 kc and 1 kc. All time-base signals originate in a 100-kc crystal-controlled oscillator.

Counts are indicated by neon lamps that show through transparent numbers from 0 to 9 arranged in vertical columns, one column for each digit. Convenient arrangement of controls and terminals unit makes the unit as flexible and versatile as possible.

Potter Instrument Co., Inc.,
115 *Cutter Mill Road, Great Neck, N. Y.*



Slip-Clutch Overload Protection Device

The Torque-Limiter, a compact, adjustable overload protection device features a powder metal bushing on which such drive components as chain sprockets, V-belt pulleys or gears can be mounted. Consisting basically of a driving or driven member combined with a spring loaded friction clutch that can be adjusted to slip when the desired torque is exceeded, the device is made up of a low carbon steel threaded and splined hub, two steel plates, two unbonded clutch facings, a powdered metal bushing, a Belleville spring and a steel or cast iron adjusting nut. The clutch plates slide on six SAE angular straight-sided splines.

The driven member (a sprocket, sheave or gear) is mounted on the

NEW!

Ohmite-compounded, special resin encloses *all parts*. Its coefficient of expansion closely matches that of bobbin, wire, and terminals.

Rigid steatite bobbin keeps pie windings in place.

Resistance wire welded to terminals insures perfect connections.

Bobbin is completely encapsulated — ends and even center hole.

OHMITE®

Proudly announces the

RITEOHM®

***completely* encapsulated**

precision resistor

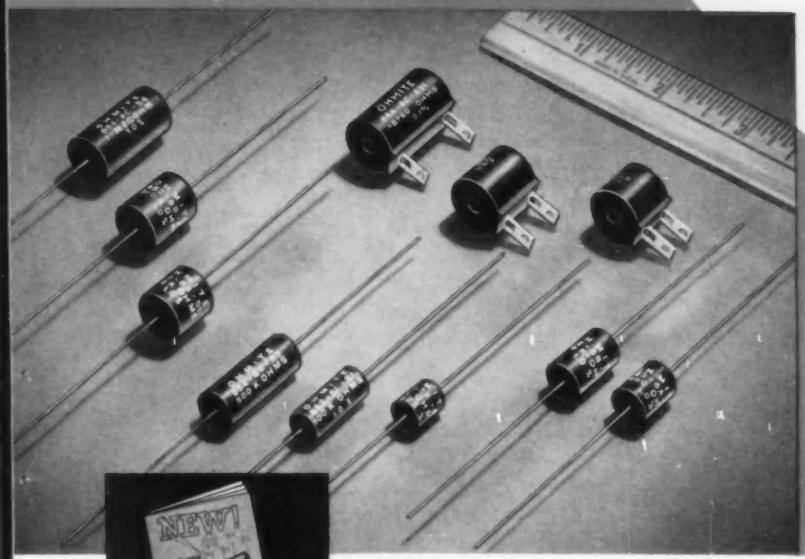
type 85 and 86

Exceeds

MIL-R-93A

Amendment 2

at 125°C ambient



Now . . . a new Ohmite encapsulated, wire-wound, precision resistor, designed to provide absolute stability. Winding is protected against moisture or mechanical damage by a rigid steatite bobbin encapsulated in Ohmite-compounded, special resin. Resistance wire is welded to terminals. Axial-lead and lug types, in sizes from ¼ to 1 watt (125° C ambient) in a wide range of resistance values. Tolerances to ± 0.1%.

Write for New Descriptive Bulletin

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RHEOSTATS
RESISTORS
TAP SWITCHES

OHMITE MANUFACTURING COMPANY, 3611 Howard Street, Skokie, Illinois (Suburb of Chicago)

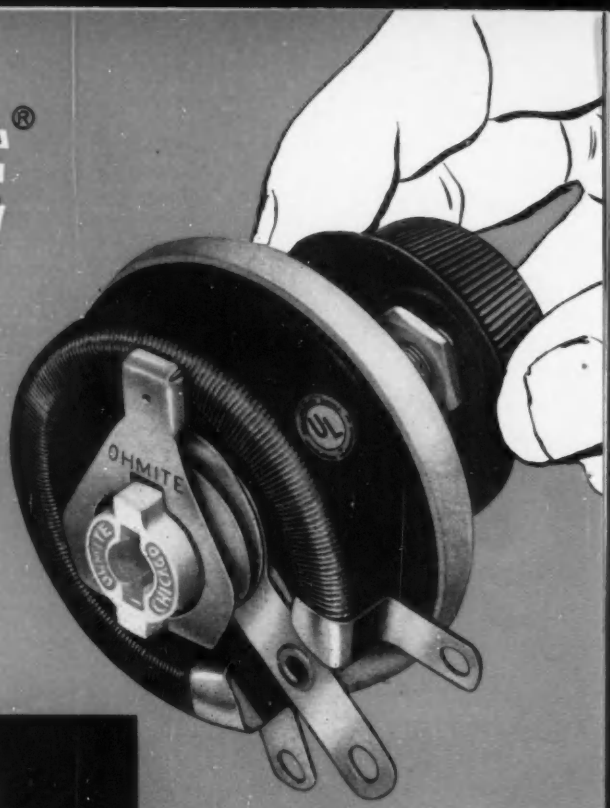
OHMITE®

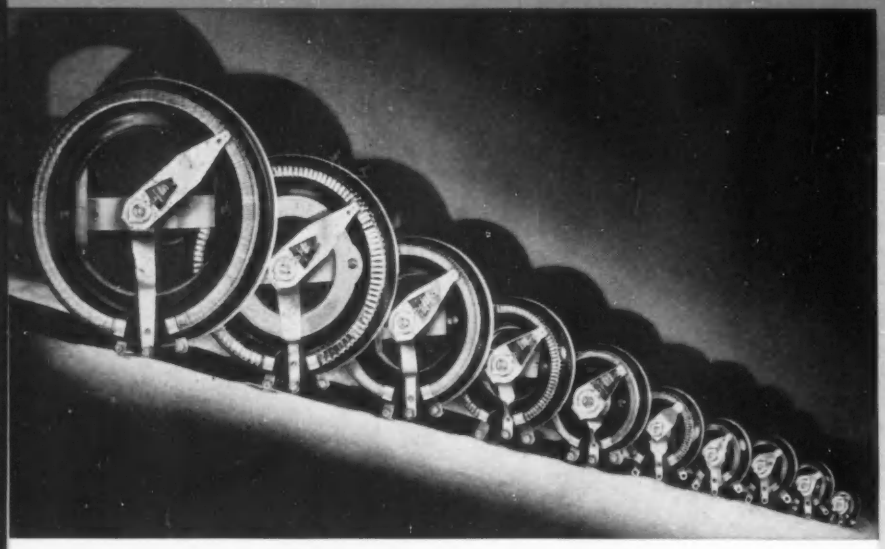
The ONLY Complete Line of

RHEOSTATS

meeting the requirements of

MIL-R-22A





OHMITE MODEL	TYPE	WATT RATING	ENCLOSED	"OFF" POSITION
H	RP101	25	NO	NO
	RP102		NO	YES
	RP103		NO	YES
	RP111		YES	NO
	RP112		YES	YES
	RP113		YES	YES
J	RP151	50	NO	NO
	RP152		NO	YES
	RP153		NO	YES
	RP161		YES	NO
	RP162		YES	YES
	RP163		YES	YES
G	RP201	75	NO	NO
	RP202		NO	YES
	RP203		NO	YES
K	RP251	100	NO	NO
	RP252		NO	YES
	RP253		NO	YES
L	RP301	150	NO	NO
	RP302		NO	YES
	RP303		NO	YES
P	RP351	225	NO	NO
N	RP401	300	NO	NO
R	RP451	500	NO	NO
T	RP501	750	NO	NO
U	RP551	1000	NO	NO

Ohmite can furnish rheostats in *every* one of the 26 type designations to meet the requirements of MIL-R-22A. By standardizing on Ohmite rheostats, you can cover all of your needs for both civilian and government jobs and, at the same time, give your customers the utmost in rheostat performance. Ohmite rheostats have proved their dependability in meeting the severe requirements of MIL-R-22A . . . the 5-hour vibration test, 50-hour salt-spray corrosion test, 150-hour 95% humidity electrolysis test . . . and others. Their all-ceramic construction . . . uniform windings locked in place by vitreous enamel . . . smoothly gliding, metal-graphite brush . . . insure close control and years of trouble-free service. It will pay you to standardize on Ohmite rheostats for your products.

OHMITE MANUFACTURING CO., 3611 Howard St., Skokie, Illinois (Suburb of Chicago)

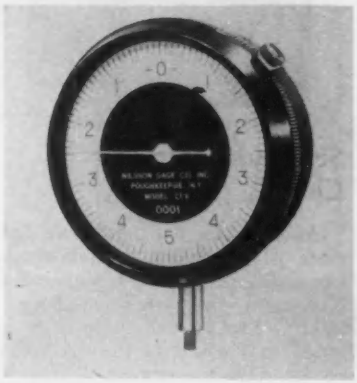
OHMITE

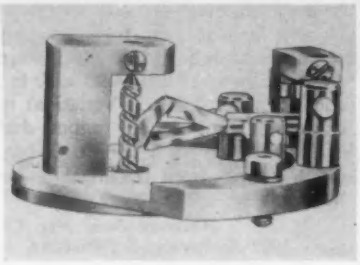
RHEOSTATS • RESISTORS
TAP SWITCHES

bushing and clamped between the clutch facings by the Belleville spring. The hub is bored to fit standard motor shafts and is held in position by a set screw.

When the torque capacity is exceeded, the driven member breaks away from the clutch facings. It then slips at from $\frac{1}{3}$ to $\frac{1}{2}$ the torque setting. When an overload condition occurs in a machine drive the components resist only from $\frac{1}{3}$ to $\frac{1}{2}$ the motor torque until the motor is shut off and the condition corrected.

Morse Chain Co., 7601 Central Ave., Detroit 10, Mich.





"Gear Train-less" Gage

The interesting feature of this new dial indicator mechanism is the fact that it functions without gear trains and so eliminates 50 percent of all moving parts as well as doing away with gear friction and wear, high maintenance costs, and the accumulative errors common to conventional mechanism. According to the designers, since it has no teeth to wear out, it is never subjected to excessive play and, as a result, will work to closer tolerances for longer periods.

The step down dial on the indicator brings scale and pointer to the same plane, offering uniform and legible readings from any angle. Instead of the usual convex lens, a flat glass crystal is used, cutting down glare as

ACE®

Controlled-property compounds meet your needs for:

MECHANICAL,

ELECTRICAL,

CHEMICAL APPLICATIONS

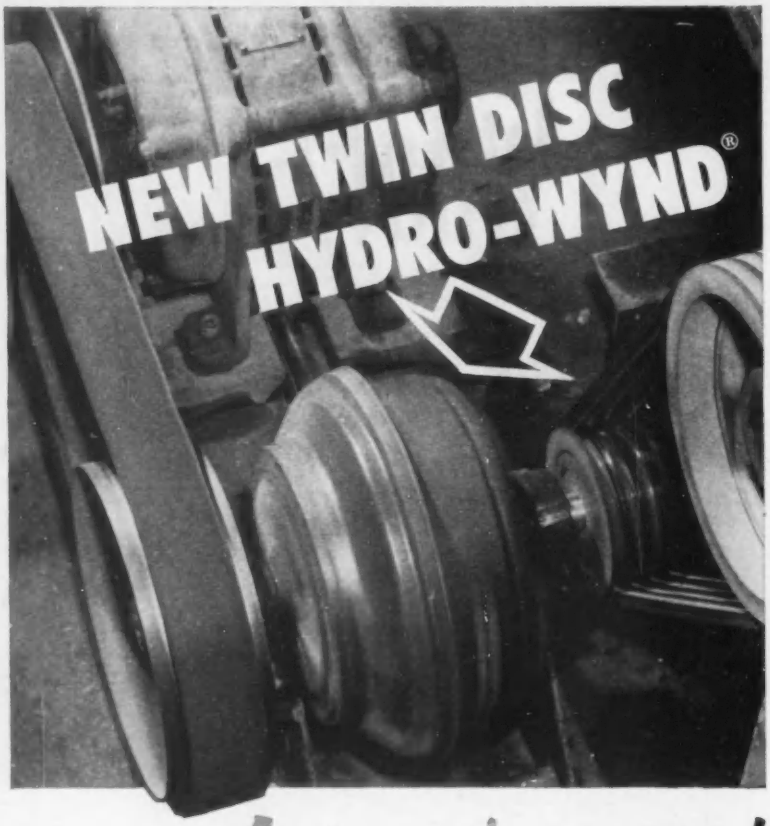
COME to think of it, we're a little amazed ourselves at the way Ace engineers can blend the mechanical, electrical and chemical properties of different rubber and plastic materials. Their aim is always to find the one best material for each of your jobs . . . never *over*designed . . . with production economy a must. Result: hundreds of tailor-made rubber, plastic, and rubber-plastic alloys to choose from . . . plus many unusual materials like Ace-Tex pyrobitumens. Ask us for anything from rough-ground rods to finished molded assemblies. Our facilities for molding, extruding, fabricating, and lining are among the world's largest.

Always check your ACE design engineer's Handbook when selecting materials for today's production and tomorrow's plans. If you haven't a copy, write today! It's Free.

ACE rubber and plastic products

AMERICAN HARD RUBBER COMPANY

93 WORTH STREET • NEW YORK 13, N. Y.



Automatic control

for winding and tensioning, at low initial cost — without unnecessary bulk or expensive maintenance

Now available in improved design*, and in larger capacity to extend the line, the new Twin Disc Model 12.2 and 8.4 HYDRO-WYND provides a *more effective, more economical answer to automatic winding and tensioning control.*

Extremely compact — easy to install—either the 12.2 or 8.4 HYDRO-WYND combines a fluid coupling with a planetary gear set. Pre-determined tensions—once set—are maintained automatically, regardless of variations in the load demand . . . and with no further adjustments required. The result . . . *higher output per day . . . improved product quality . . .* fewer man hours required.

For complete information on the new HYDRO-WYND, call your Authorized Twin Disc Hydraulic Dealer—or write Dept. DS, Racine, Wisconsin.

*New HYDRO-WYND design features include rearrangement of gear train, better bearing spacing, and new carbon-against-steel spring-loaded seal.

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

TWIN DISC

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

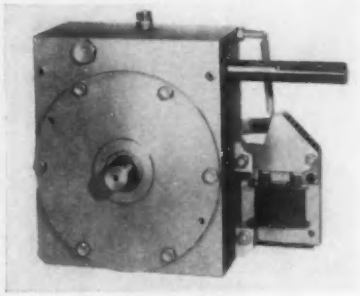
Branches or Sales Engineering Offices: Cleveland • Dallas • Detroit • Los Angeles • Newark • New Orleans • Seattle • Tulsa

well as possible distortion and parallax errors.

The unit comes in three sizes: 1¼ in., 1$\frac{11}{16}$ in., and 2¼ inches.

For more information on this gage, write to the manufacturer.

Nilsson Gage Co., Poughkeepsie, N. Y.

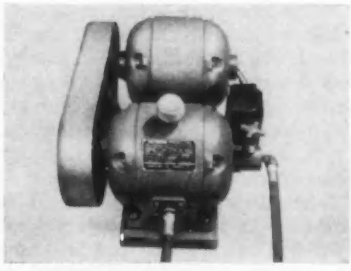


Solenoid Controlled Clutch

Available for one revolution, fractions of a revolution or multi-revolutions, this new clutch is engaged or disengaged by merely touching a switch. Starting and stopping is instantaneous whenever the solenoid is energized or de-energized.

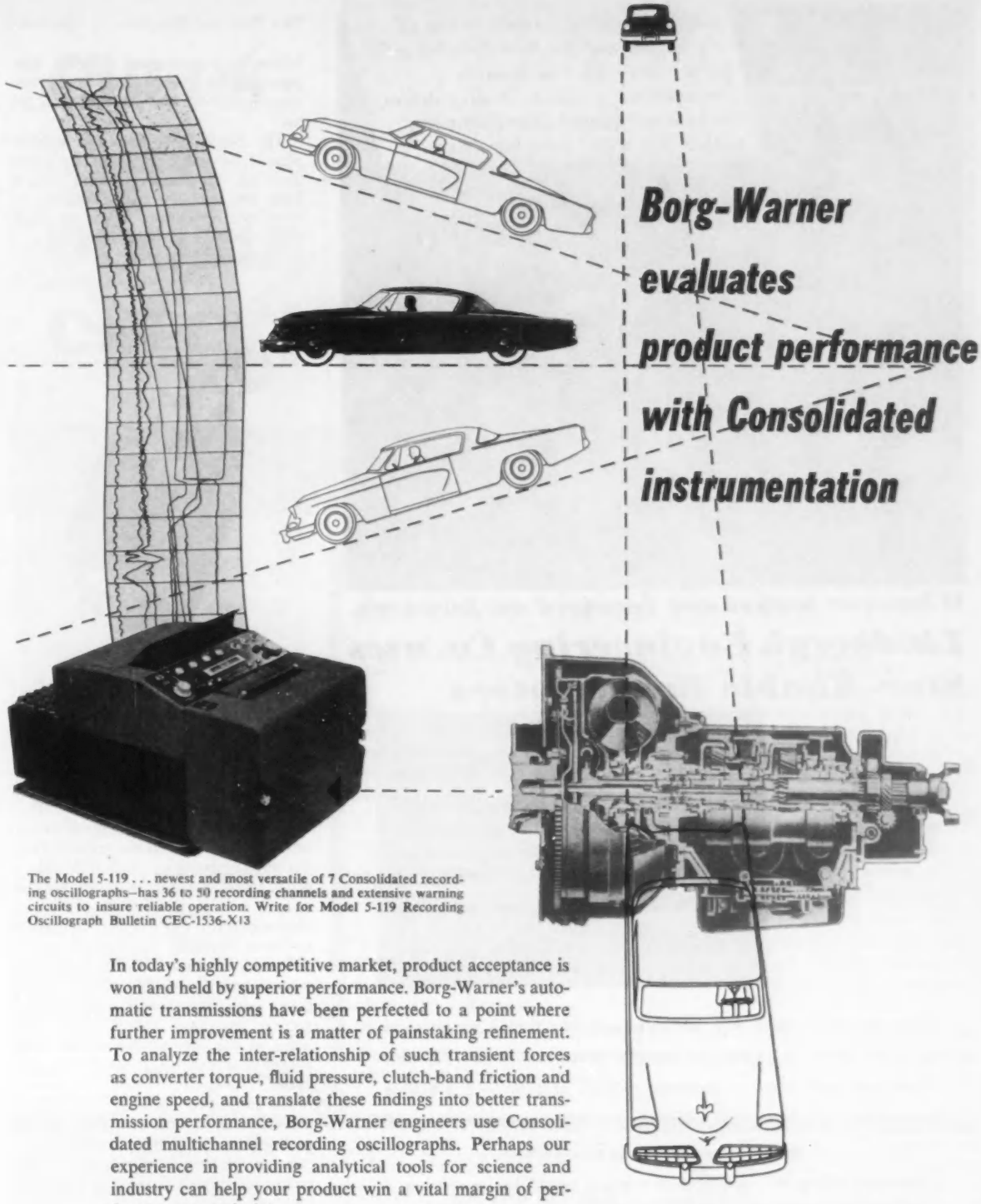
The unit is self-contained and may be mounted as an assembly. Operation features include instantaneous starting, positive stopping, and a built-in worm gear type speed reducer with a 20 to 1 and 40 to 1 reduction. Variations include single or double output shaft extension, left-hand or right-hand input, ratings from fractional to one horsepower.

Anderson Bros. Mfg. Co., 1907 Kishwaukee St., Rockford, Ill.



High Pressure Hydraulic Pump Package

A new high pressure electric hydraulic pump package, called the series H hi-thrust pump is capable of delivering 2.04 gal per min at 8,800 psi in



Borg-Warner evaluates product performance with Consolidated instrumentation

The Model 5-119 . . . newest and most versatile of 7 Consolidated recording oscillographs—has 36 to 50 recording channels and extensive warning circuits to insure reliable operation. Write for Model 5-119 Recording Oscillograph Bulletin CEC-1536-X13

In today's highly competitive market, product acceptance is won and held by superior performance. Borg-Warner's automatic transmissions have been perfected to a point where further improvement is a matter of painstaking refinement. To analyze the inter-relationship of such transient forces as converter torque, fluid pressure, clutch-band friction and engine speed, and translate these findings into better transmission performance, Borg-Warner engineers use Consolidated multichannel recording oscillographs. Perhaps our experience in providing analytical tools for science and industry can help your product win a vital margin of performance superiority.

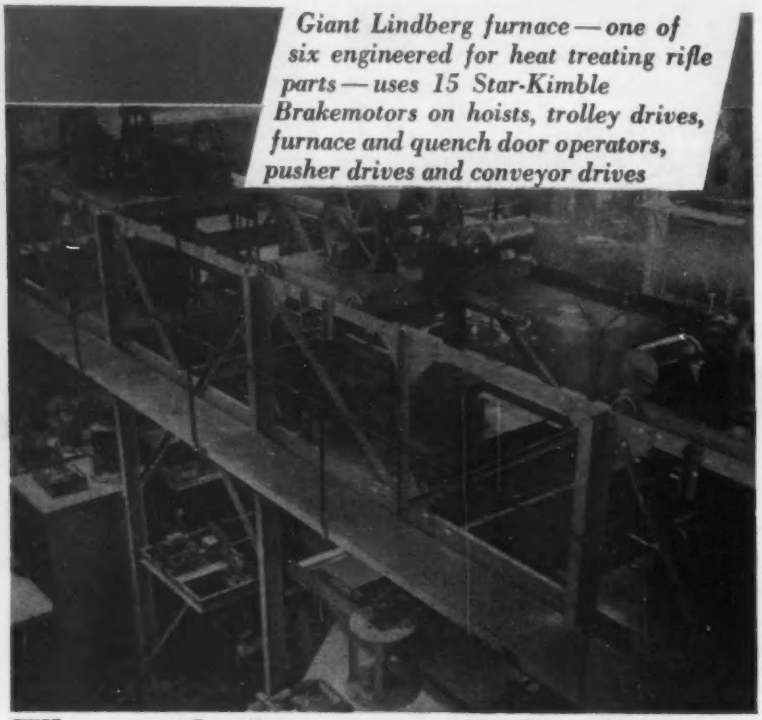
Consolidated Engineering

CORPORATION

300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service through **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, Chicago, Dallas, Detroit, New York, Philadelphia, Washington, D. C.*

ANALYTICAL INSTRUMENTS FOR SCIENCE AND INDUSTRY



Giant Lindberg furnace — one of six engineered for heat treating rifle parts — uses 15 Star-Kimble Brakemotors on hoists, trolley drives, furnace and quench door operators, pusher drives and conveyor drives

Wherever brakes are required on furnaces,

Lindbergh Engineering Co. uses Star-Kimble Brakemotors

BECAUSE

1 *Installation costs are lower.* Motor and brake mounted on a single sturdy shaft. NO ALIGNMENT PROBLEMS.

2 *Work positioning remains accurate.* Brakemotor stops are split-second in timing — maintain their precision because of low, even brake wear.

3 *Maintenance costs are lower.* Brake wear is extremely low — result of extra-large braking area and use of wire-reinforced brake linings.

Those are the reasons why Lindberg uses Star-Kimble Brakemotors *exclusively* wherever brakes are needed. When service calls for fast, smooth stop-start cycles — *repeated millions of times* — Star-Kimble Brakemotors will do the job with little or no maintenance attention.

For complete information, write for Bulletin B-501-A.

Standard and special motors of all types, 1 to 125 hp; generators and motor-generator sets, 1 to 100 kw; marine motors, ½ to 125 hp.

Star-Kimble

MOTOR DIVISION

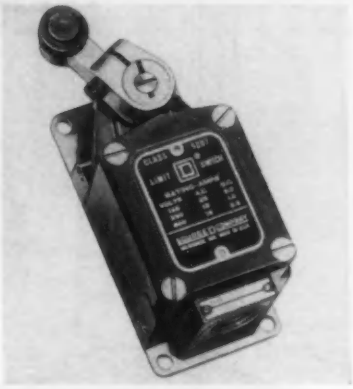
Miehle Printing Press and Mfg. Co.

211 Bloomfield Avenue Bloomfield, New Jersey

intermittent operation. Higher outputs can also be obtained at lower pressures up to 4.5 gal per min at 6,200 psi.

The pump is a six-piston wobble-plate type with operation in either direction. It has operating speeds from 900 to 2,200 rpm displacing 57 cu in. per revolution. Units are available with 2, 3, or 5 hp 220/440 v, 3 phase 60 cycle motors.

Manco Mfg. Co., Bradley, Ill.



Limit Switch: 11 Arrangements In 1

This unusually versatile machine tool limit switch can be easily adjusted to obtain 11 different contact operating sequences—using only a screwdriver.

A variety of operating lever arms are available, which can be mounted in any angular position. Although only a small travel is required to operate the switch, a large amount of overtravel (approximately 80 deg) is provided in either direction.

Diecast enclosures are fully gasketed with neoprene, making them watertight, oiltight and dust tight. Seven types of baseplates, as well as threaded holes in the side of the diecast box, permit mounting in a variety of positions.

For simplified stocking, basic switch units and lever arms are individually packaged so that different applications can be met by simply selecting the proper lever arm for use with the basic switch.

Square D Co., 4041 N. Richards St., Milwaukee 12, Wisc.

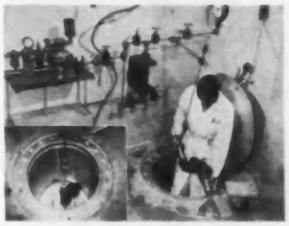
Heat Resistant Locknut

Designed to meet the need for high-temperature fasteners in today's aircraft engines and industrial processes,

CHECK & DOUBLE CHECK!

is the CHIKSAN creed...

A 30" optical comparator in CHIKSAN'S Inspection Department helps further improve quality control of all swivel joint parts.



The High Pressure Burst Chamber subjects CHIKSAN joints and assemblies to 80,000 lbs. pressure to test possible material flaws.

Hydraulic fluid pressure tests of every CHIKSAN aero hydraulic swivel joint is the final check step before shipment.

When YOU buy—SPECIFY CHIKSAN Ball-Bearing Swivel Joints for Safe, Sure, Economical performance.

Check and double check is your guarantee of the finest ball-bearing swivel joints for your money. Checks include: Inspection prior to machining; Inspection by machinist; Spot check by line inspector; 100% inspection of all components before assembly; and 100% hydrostatic testing of assembled joints. This meticulous procedure insures quality control of all Chiksan products.

Through a quarter century, more than one million Chiksan joints have served satisfied users in the transfer of fluids and gases in flexible lines. Constant and continuing research and testing are your assurance that the swivel joints manufactured by Chiksan will continue to offer more for your money than any other type of swivel joint, swing joint or fitting.

Chiksan offers the largest and most complete line of swivel joints in the world. Standard sizes range from ¼" to 12" with larger sizes available on special order. Our engineers have had years of experience in solving flexible line problems in every major industry.

You can avail yourself of Chiksan's experience. There is a Chiksan office or Representative near you for close, personal assistance. Write today for catalog information. Department 5, P.E.

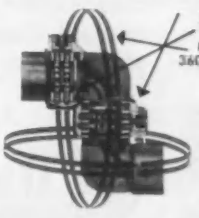
CHIKSAN

The Flow of Enterprise Relies on

CHIKSAN

Ball-Bearing Swivel Joints

THE NEW TOOL OF MODERN INDUSTRY



CHIKSAN Ball Bearing Swivel Joints are THE NEW TOOL of Modern Industry with full 360° rotation in 1, 2, and 3 planes. Over 1,000 different types, styles, and sizes have been developed for pressures and services from 28" vacuum to 15,000 psi and for temperature ranges from minus 70° to a plus 350° F. with packing materials for each specific service.

CHIKSAN COMPANY • BREA, CALIFORNIA • Chicago 3, Illinois • Newark 2, New Jersey

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Co., Brea, Calif.; Newark 2, N. J. • Chiksan of Canada Ltd., Edmonton, Alta.

What's your cylinder problem?

Big one: Anker-Holth Rotating Hydraulic Cylinder with 21" bore and 20" stroke, for 3000 psi. Little one: Anker-Holth Air Cylinder with 3" bore, 3" stroke.

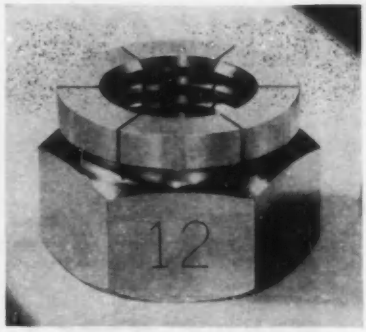
Anker-Holth has the answer!

• Your problem in power motion may be far removed from the Anker-Holth Cylinders shown above. Whatever your need for air or hydraulic cylinder power, Anker-Holth has the engineering know-how and manufacturing facilities to match your specific requirement. Anker-Holth engineers will gladly assist you. Call or write Anker-Holth Division of The Wellman Engineering Company, Dept. F-3, 2723 Conner Street, Port Huron, Michigan.

Anker-Holth
ENGINEERED CYLINDER POWER
WELLMAN

FREE on request... bulletin on complete line of Anker-Holth products.

Division of THE WELLMAN ENGINEERING COMPANY



this new self-locking nut will resist temperatures up to 1,200 Fahrenheit.

The nuts—machined from AMS-5642 stainless steel—are silver plated to eliminate galling and seizure of threads. Under test they conform to military specification MIL-N-7873.

Capable of withstanding the heat in the tail cone of a gas turbine, the locknuts are also designed for such applications as exhaust manifold systems, furnaces and firewall assemblies. They are stop nuts as well as lock nuts; they lock in place at any point along the bolt or stud, whether seated or not.

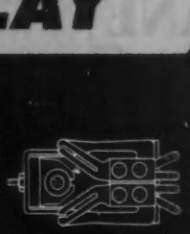
Standard Pressed Steel Co., Jenkintown, Penna.

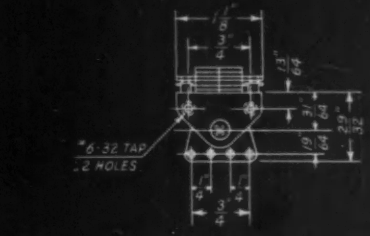
Flow Sensitive Pressure Regulator

This new device responds to the flow of oil entering it in such a way that the relief valve setting decreases as the inlet flow decreases. As a result, a fixed displacement hydraulic pump will not stall when the input torque is reduced below that value required to meet the setting of an ordinary fixed setting pressure relief valve.

Accordingly, an emergency hydraulic system can always depend on an in-

Here's a CLARE RELAY





that has changed a lot of design ideas

Compare these features of the CLARE Type J Relay with ordinary telephone-type relays

Extremely Small Size—Length: 2¼", Width: 1⅛", Height (with 10 springs): 1¾", Net Weight: 2¼ oz. (approx.).

Large Current Capacity—Rated current carrying capacity: 4 amperes, 150 watts. Twin contact points (Palladium) standard.

Exclusive New Features—Twin contacts operate independently of each other—minimize chance of contact failure.

Largest possible bearing surface for hinge-type armature.

Armature bearing pin turns in cylinder of different metal which is full width of the heelpiece.

Heelpiece designed and processed for extreme rigidity to take and hold fine adjustments.

Versatile Operation—Standard coils provide for fast operate and fast release (minimum of 1 to 2 milliseconds). Coils may be provided for time delay on operation, time delay on release, or both. Also available, double-wound coils. Operating voltage up to 220 volts d-c.

Armatures may be single (right or left) or double. Residual: lock screw (adjustable) or fixed.

Relays may be mounted on mounting bases or strips as well as upon mounting bars and individual mounting brackets. Also available with plug-in mounting.

Available with slip-on dust-tight covers or hermetically sealed in metal enclosures.

• No fully acceptable substitute has ever appeared for the conventional telephone type relay. It offers a versatility of performance and flexibility of installation that meet the requirements of the widest variety of industrial designs.

Prior to the introduction of the CLARE Type J Relay, however, designers were handicapped by the comparatively heavy weight, large size and certain operational limitations of this type of relay.

The CLARE Type J changed all this. Here, for the first time, was a light-weight, small-size relay of the telephone type. It not only gave comparable performance advantages but added certain exclusive features which offered a new conception of efficient, long-life relay operation.

This relay, among other features, provided *independent* twin contacts to preclude contact failures; the largest possible armature bearing surface, thus insuring stable operation and little adjustment change over a great number of operations; and an extremely rigid heelpiece to take and hold fine adjustments. (A fine adjustment will shift when a weak heelpiece is distorted by tightening the mounting screws.)

Acceptance of the CLARE Type J Relay has been phenomenal. It has replaced the old style telephone type relays in innumerable designs where small size and light weight were of prime importance. If you are not familiar with the features and characteristics of this relay, we invite you to contact your nearest CLARE sales engineer or write to: C. P. Clare Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY. ***Write for Engineering Data Book.***

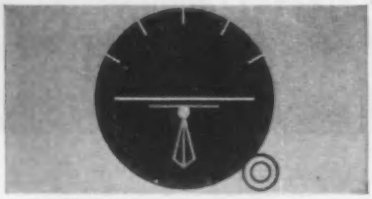
CLARE RELAYS

FIRST IN THE INDUSTRIAL FIELD

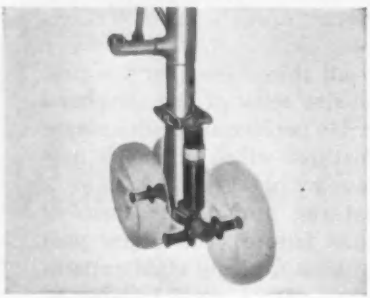
SYNTHANE

laminated plastics at work

In heavy equipment A number of Synthane parts are used in this king-sized power shovel. Electrical strength, chemical resistance and mechanical durability are all required for this application.



In light equipment Tiny, but highly accurate, Synthane ball retainers are used in this sensitive aircraft instrument. Durability, light weight and minimum friction are all needed on this job.



In shock struts The landing gear pistons on some of our largest planes are made of Synthane. Properties of light weight, toughness, durability and shock resistance were needed; Synthane supplied them.

What's your PROBLEM?

MAIL COUPON FOR FREE FOLDER

Our 25th Year

SYNTHANE CORPORATION

4 River Road, Oaks, Pa.

Please send me your free folder describing advantages, properties, uses, and kinds of Synthane plastics.

Name_____

Title_____

Company_____

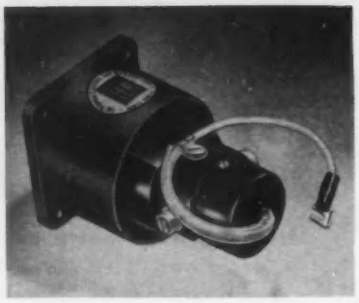
Address_____

City_____ Zone_____ State_____

stantly available flow at whatever pressure the power source is capable of producing. Although a 3,000 psi hydraulic system may deteriorate to 500 psi or less, total power will not be cut off merely because a conventional 3,000 psi relief valve has stalled the pumping source.

The valve, when not in use, rests in an open position. Starting torque, therefore, is low—increasing in magnitude as delivery increases. Air trapped in the system will be purged as the valve begins passing fluid.

Vickers Inc., 1400 *Oakman Blvd., Detroit* 32, *Mich.*



Miniature Motor-Blower Assembly

Designed to occupy a space no larger than 2¼ in. by 2¼ in. by 4 in., this unusually compact motor-blower assembly will, according to its manufacturer, supply 24 cfm free air delivery under continuous duty.

Either blower or suction operation is afforded by the unit's two blade, propeller-type fan, powered by a permanent magnet motor rated at 6 to 115 volts d-c. Speed is 10,000 to 13,000 rpm, with 0.50 ampere current consumption. The assembly's housing is cast aluminum, and it can be equipped with a radio noise filter.

Pioneer Electric and Research Corp., 743 Circle Ave., Forest Park, Ill.

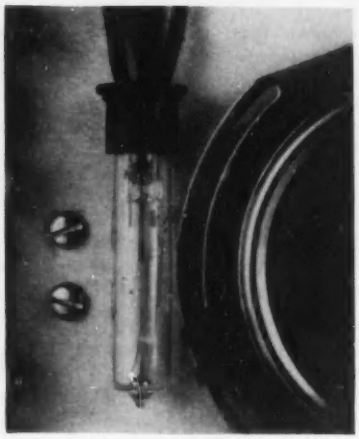
Lightweight Reference Cavities

Three new reference cavities, each with only plus or minus 0.4 mc maximum frequency drift under typical operating conditions, have been designed as frequency determining references in microwave systems, such as radar beacon receivers.

The cavities—the GL-1Q26-A, resonant frequency 9280 mc (shown here); the GL-6301, resonant frequency 9270 mc; and the GL-6452, resonant frequency 9350 mc)—are of the fixed-frequency, vacuum sealed, transmission type. Their tightened specifications, light weight and small size should permit design of new equipment that will provide more reliable service—through better frequency stability—than was previously obtainable with this type of device.

Each cavity weighs approximately eight ounces, and can be used in pressurized systems. They will withstand 10 G's vibration with only plus or minus 0.1 mc frequency drift, and temperature changes from —40 to 100 C with only plus or minus 0.4 mc frequency drift.

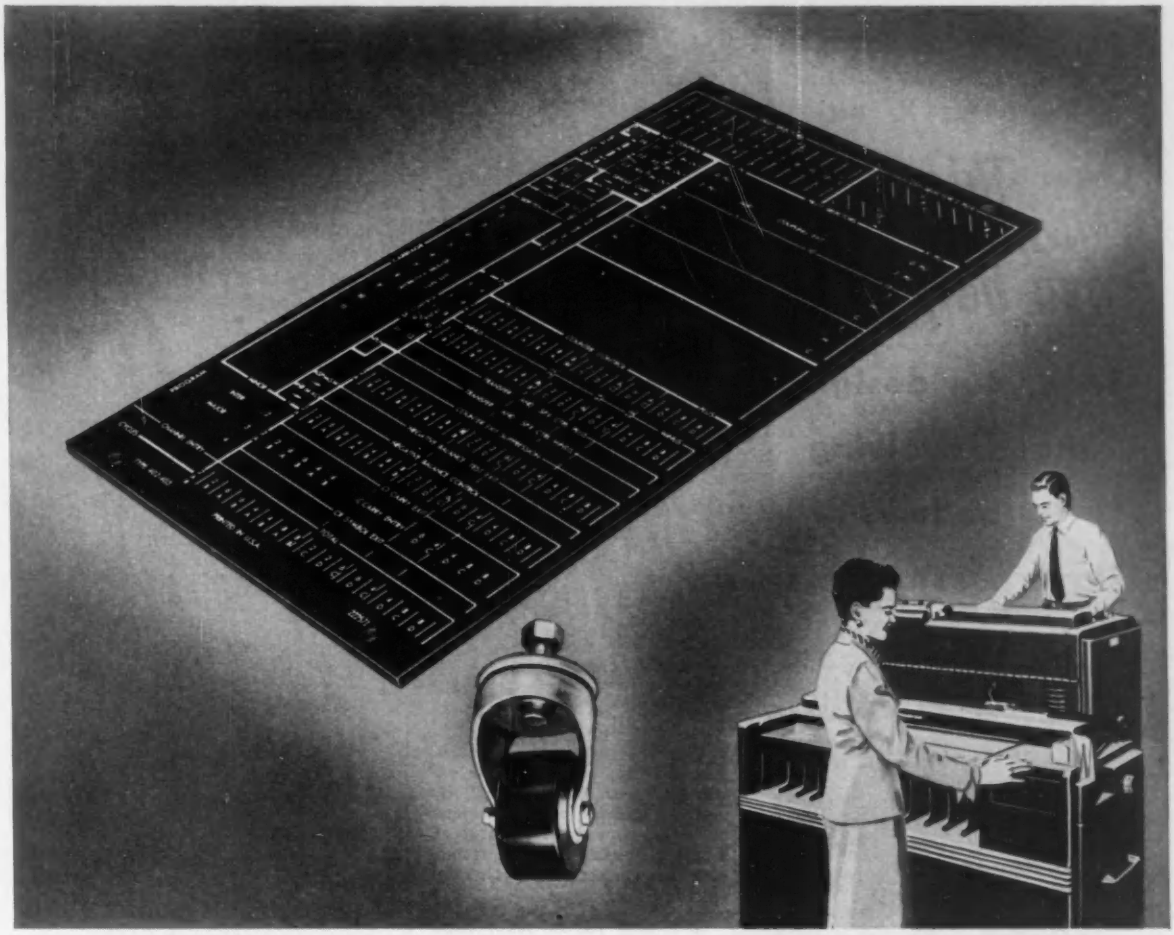
General Electric Co., Schenectady 5, *N. Y.*



Hermetically Sealed Mercury Switch

Unaffected by dirt, dust or corrosion, this new switch offers all contacts enclosed in a glass tube, visible for quick inspection. Contacts are not subject to oxidation, open arcing, pitting or sticking.

Designed for use as a position indicating and limit switch in conjunction with precision equipment, the unit is of the single pole, double throw, mag-



Head and feet for an office worker who neither errs nor tires

Properties of Synthane

In addition to those mentioned in the text, Synthane has the following important properties:

Chemical resistance. Synthane resists most acids and alkalis in moderate solutions, and corrosive atmospheres.

Temperature resistance. Synthane is thermosetting, will not flow under elevated temperatures. Grades resisting up to 400° F are available.

High impact strength. Synthane stands up well in applications where it is subject to vibration, pounding and shock loads.

Mechanical strength. Synthane exhibits excellent strength under tension, compression, and other loads. It will not delaminate.

Availability. Synthane is supplied in more than 33 grades of sheets, also in rods, tubes and molded-laminated or molded-macerated parts. A complete fabricating service is available.

• The uncanny ability of tabulating machines to do complicated jobs quickly and accurately is famous. One of the materials which helps to make this possible is *Synthane*—a laminated plastic.

Synthane serves as the base for the brains of the machines—the plug boards upon which the control circuits are set up. *Synthane* is excellent for the purpose because of its combination of high dielectric strength, resistance to moisture, dimensional stability and ease of machining. *Synthane* is printable, too—circuit designations are readily printed on its surface.

On tabulating machines, casters that are friendly to office-type flooring are needed. Casters of molded-macerated *Synthane* fill the bill. *Synthane* caster wheels are strong, do not flatten by constant pressure, and do not mar office floors.

Should you require a versatile material—one with many properties in combination—*Synthane* may be your answer. Our catalog tells the full story. To receive yours, drop us a note on your letter-head. Synthane Corporation, 4 River Road, Oaks, Pa.

Our 25th Year

SYNTHANE CORPORATION, OAKS, PA.

SYNTHANE
LAMINATED S PLASTIC

This man can help you

with your design plans involving bellows or bellows assemblies

M. G. CALHOUN
one of our staff of bellows application engineers.

HE CAN SHOW you how a bellows assembly can do the job. He will work with you on the bellows design . . . advise you on the metal required – brass, stainless steel, monel or nickel. He will recommend the correct bellows charge– volatile liquid or gas.

He'll help you on many more factors that will make your design plans more efficient. You'll be assured of a bellows assembly *exactly* suited to your needs–to help your products perform as planned.

There are many uses for Sylphon and Bridgeport bellows assemblies –for thermostatic devices, pressure controls, hydraulic mechanisms, expansion joints, motion transmission, as flexible connectors and in more applications.

Let our engineers, our half-century of experience and ample production facilities work for you – save you time, money and trouble. Get full information. Write today.

SEND FOR FREE BULLETIN

Idea-filled Bulletin tells you all about metal bellows and bellows assemblies. Send for your free copy today. Ask for Catalog JP-1400.

Robertshaw-Fulton
CONTROLS COMPANY

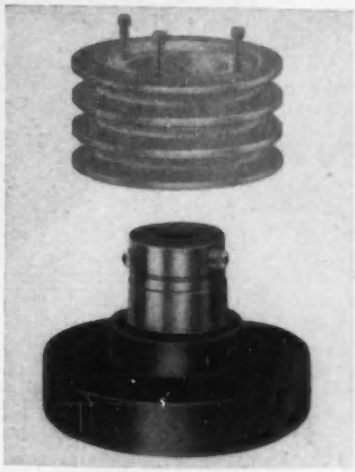
FULTON SYLPHON DIVISION KNOXVILLE 1, TENNESSEE

BRIDGEPORT THERMOSTAT DIVISION BRIDGEPORT 1, CONNECTICUT

netically actuated mercury type. As a small moving magnet approaches the armature within the switch, the electrodes are moved in and out of the mercury to mechanical friction is involved.

Standard operating ranges are from 12 v at 0.25 amps to 120 v at 1 amp. Tube dimensions: $1\frac{1}{2}$ in. dia by $2\frac{1}{2}$ in. length, with a standard cap $\frac{3}{4}$ in. dia by $\frac{1}{2}$ in. length.

Hamlin, Inc., 1316 *Sherman Ave., Evanston, Ill.*



Lightweight, Compact Automatic Clutch

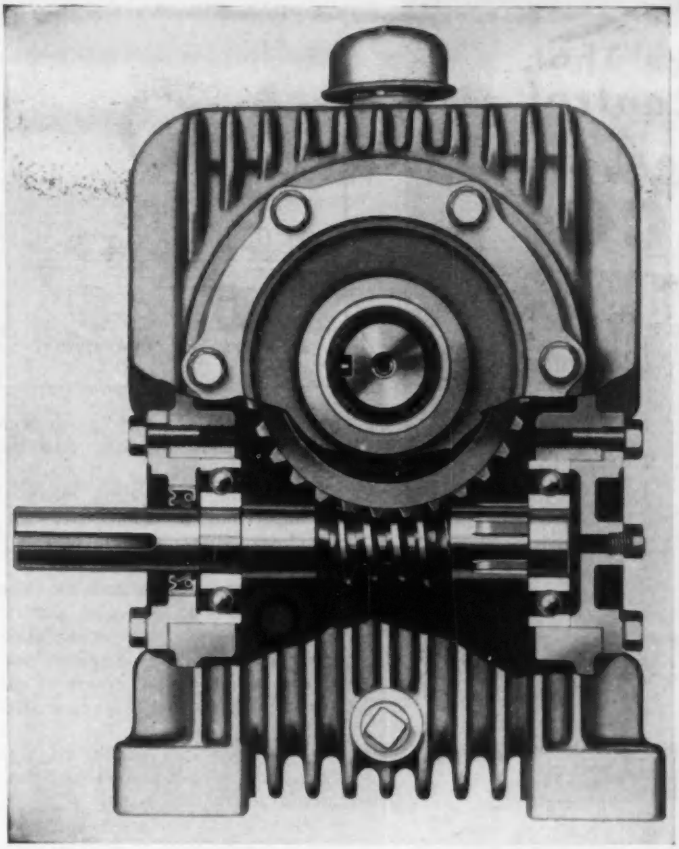
Designed for use on gasoline engines from three to 10 hp, with 1 in. and $1\frac{1}{8}$ in. dia shaft extensions, and on electric motors from two to five horsepower, 1,750 rpm, this new clutch provides load-free starting and idling for engines.

The model, which can be installed without altering present shaft extensions, picks up the load smoothly—but positively—when the engine is accelerated. The clutch, says the manufacturer, will reduce starting current demand and offer overload protection for electric motors.

The Salsbury Corp., 1161 *E. Florence Ave., Los Angeles* 1, *Calif.*

One-Piece O-Ring And Washer

A one-piece washer and rubber O-ring combination, with the O-ring bonded to the washer is available in sizes from $\frac{3}{16}$ in. to $\frac{5}{8}$ in. nominal bolt diameter. According to the manufacturer, the units will provide leak-proof sealing against fluids, gases or air



•

MORE HP PER POUND

•

MORE HP PER CUBIC INCH

•

MORE HP PER DOLLAR

TAKE A LOOK AT EFFICIENCY

. . . it belongs in every driven product

You're looking at the "innards" of the most efficient worm geared speed reducer available today. It's Cone-Drive Gear's exclusive double-enveloping worm gear design, which means more load-carrying capacity, size for size, than any other type of right-angle speed reducer.

This simple design, with the gear and worm literally "wrapped" around each other, means a space and weight savings that often makes the difference between a compact, efficient product and just another machine.

You can specify (from stock) any one of 190,000 standard models of Cone-Drive gears to handle loads from fractional to 800 hp. You can have ratios from 5:1 to 4900:1. Fan-cooled or water-cooled models available if you should need them.

Interested? Get complete details in Bulletin 8901-50.

CONE-DRIVE GEARS

Division, Michigan Tool Company

DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS

7171 E. McNichols Road • Detroit 12, Michigan

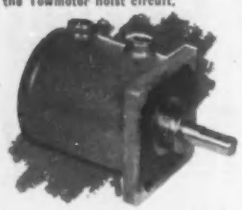
It's No Coincidence That
TowmoTorque Control
is Oil Powered by
HYDRECO

The famous HYDRECO Four-Bolt design gear-type Pump for 1000 to 1500 psi applications is the heart of the Towmotor hoist circuit.

Advanced engineering ideas, like the Towmotor TowmoTorque drive, have joined forces with HYDRECO Oil Power too consistently to be a coincidence.

Of interest to design engineers is the hydraulics problem successfully solved here. The control of the torque converter drive through a specially-designed HYDRECO valve enables the operator to control vehicle speed independently of the hoisting speed. For example, the operator can drive the truck forward and backward very slowly while raising the load at maximum speed. Other HYDRECO components on this truck include a special cylinder and relief valve for the TowmoTorque, and a pump, control valve and cylinder for the hoist circuit.

HYDRECO Oil Power is providing a definite sales advantage to more and more makes and models of mobile equipment, machine tools and special machinery. And, frequently you'll find that the things you're dreaming up are problems already solved by HYDRECO engineers.



A compact HYDRECO cylinder designed with low-friction characteristics actuates the TowmoTorque drive.

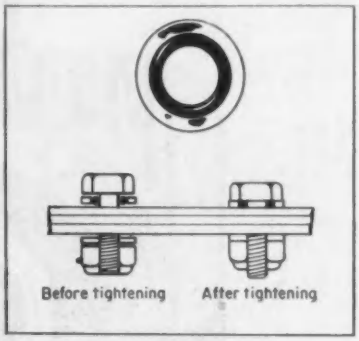
This HYDRECO relief valve is used on the torque converter to protect the heat exchanger from excess pressure.

Located beneath the floorboards is the HYDRECO-designed valve, one plunger of which is connected to a hand lever and hydraulically controls the forward and reverse motion of the truck. The other plunger, connected to a foot pedal, controls the vehicle speed regardless of engine speed.

Write

Write for the latest HYDRECO bulletins on Pumps, Motors, Valves and Cylinders.

HYDRECO DIVISION
THE NEW YORK AIR BRAKE COMPANY
1112 EAST 222nd STREET • CLEVELAND 17 • OHIO



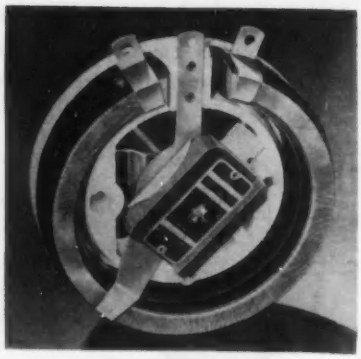
around bolts where they go through walls, bulkheads, or skins retaining such fluids or gases.

In addition, the sealing materials are impervious to atmospheric elements, salt water, gasoline, oil and most organic solvents.

Called Duo-Seals, the units are color coded according to use—fuel, general purpose, high temperature or oil. Their permanently bonded, one-piece construction eliminates the danger of the O-ring slipping either during or after installation.

For further information on this new sealing combination, write to the manufacturer.

Rubber Teck, Inc., 19115 *S. Hamilton St., Gardena, Calif.*



Ring Type Rheostat Offers Smooth Control

A new 300 watt ring rheostat, designed for use in a-c and d-c circuits where smooth, accurate current control is essential, is said to be particularly useful where "stepped" rheostats do not furnish sufficiently close adjustment.

Typical control applications include: generator and motor field, electron tube, battery charging, oven and lamp dimming control.

The base and core consist of high grade, high dielectric strength ceramic. Vitreous enamel bonds the base to the

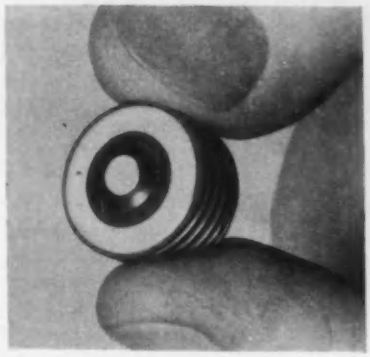
core and permanently locks the special alloy resistance wire in place.

Contact armed assembly features: 1-balanced steel arm equipped with two sintered, self-lubricating copper graphite shoes; 2-heavy compression spring, housed in a cold molded insulator, maintains uniform contact shoe pressure on resistance winding and collector ring; 3—corrosion resistant, $\frac{3}{8}$ in. diameter steel shaft turns in a self-lubricating sleeve bearing.

The diameter is 6 in., the back-of-panel depth only $2\frac{3}{16}$ inches. Resistance values range from 1 to 2500 ohms. Rating is 300 watts, based on 300 C use.

For more information on this rheostat contact the manufacturer.

Ward Leonard Electric Co., Mount Vernon, N. Y.



Helium Filled Switch Button

This hermetically sealed switch "button" consists of a set of movable contacts in an accordion-like diaphragm enclosure filled with helium gas under pressure. According to the manufacturer, it will reduce arcing and pitting and will perform at any altitude, even in a complete vacuum. It is recommended where ordinary exposed contacts can be affected by dirt and dust and also may be used in applications where combustible materials are present (since there is no exposed arcing).

Manufacturer also claims that the product will be valuable for use in solenoid actuated contactors, replacing the usual silver contacts. The reduction in arcing and pitting is brought about because the high pressure helium gas cuts down ionization and oxidation.

For more information on this new switch, write to the manufacturer.

Slater Electric & Mfg. Co., Inc., Woodside, N. Y.

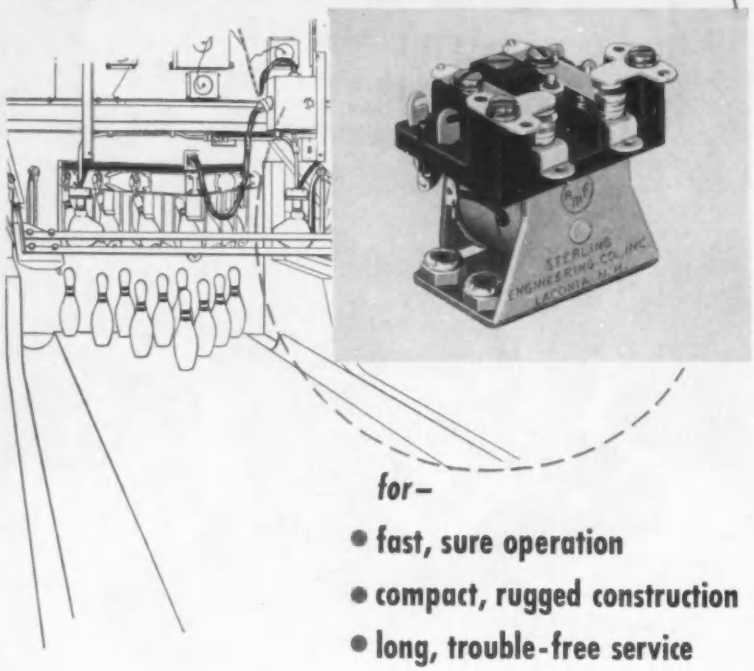
A High Pressure Pump at a Low Pressure Price!

- COMPLETE HYDRAULIC BALANCE . . . the exclusive DUAL-VANE Design provides and assures complete balance of all hydraulic pressure loads. You get continuous, maintenance-free operation with increased efficiency at all pressures.
- INCREASED OUTPUT . . . machine efficiencies can be increased by 2000 psi pump operation without change of other standard components in the hydraulic system.
- CARTRIDGE CONSTRUCTION . . . all pumping parts that move are contained within an easy-to-install cartridge. Pump output can be altered by changing cartridge; servicing is simplified and machine down-time reduced.
- ECONOMY . . . the low initial cost and the 2000 psi premium performance of DUDCO PF-100 Pumps can double the value of your *hydraulic dollar.*

Write for DUDCO Bulletin No. DP-302. You'll get the facts on the new PF-100 Series Pumps.

DUDCO DIVISION
THE NEW YORK AIR BRAKE COMPANY
1712 EAST NINE MILE ROAD • HAZEL PARK • MICH.

Automatic Pinspotters too, rely on STERLING RELAYS



for–

- **fast, sure operation**
- **compact, rugged construction**
- **long, trouble-free service**

These amazing machines perform *automatically* every pit function in bowling, on a 17-second cycle, 24 hours per day! Six STERLING Relays in the machine's "brain" reliably coordinate a multiple series of electric and electronic circuits which actually enable it to "remember" and act with almost human intelligence ... and superhuman accuracy!

To meet their exacting requirements, the manufacturers of Pinspotters rely on STERLING Type PS Relays—one of the many types of STERLING Relays used by leading manufacturers of electrically- and electronically-controlled equipment.

General Specifications: Sterling Type PS Relay

COIL—single wound to 220 volts AC or DC • POWER CONSUMPTION—2.5 watts DC—4.5 V.A. AC • OPERATE TIME—approx. .025 sec. • RELEASE TIME—approx. .010 sec. • SPRING COMBINATION—2C (DPDT). #10 (¼" silver) contact is standard. Contact Codes 3, 9, 11 and 12 are also available. • MOUNTING—4 #6-32 stop nuts on ½" x 1-5/16" centers; four 7/32" clearance holes on same centers also available. • DIMENSIONS—1½" x 1⅝" x 1-13/16" high. • WEIGHT—approx. 4 oz.

May we send you the STERLING Relay Catalog or make up a test relay to fit your specific needs? Write STERLING ENGINEERING COMPANY, INC., 54 Mill St., Laconia, N.H. (Subsidiary of American Machine & Foundry Company, New York.)

Another AMF Product
Sterling RELAYS
Laconia, New Hampshire

Catalogs and Bulletins

Request additional information using postcards following page 228

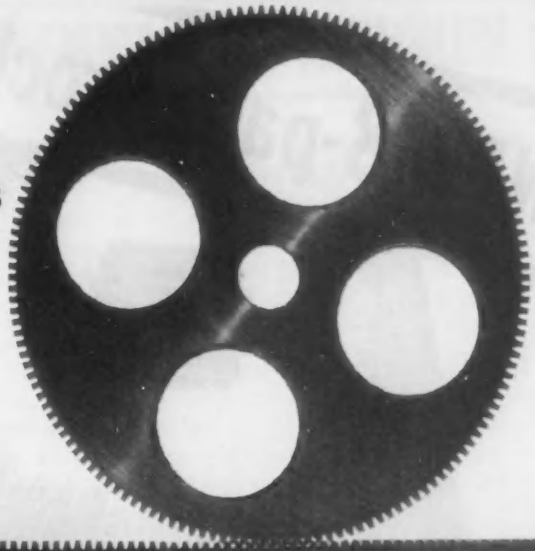
(1) BERYLLIUM COPPER TUBING—Superior Tube Co., 1556 Germantown Ave., Norristown, Pa. Booklet 7-2, 9 pp. Contains the properties, applications and advantages of seamless, and welded and drawn beryllium copper tubing, mechanical and physical properties, heat-treating procedures, welding and brazing methods, pickling solutions, corrosion resistance tables, standard production limit tables, and tubing tolerances.

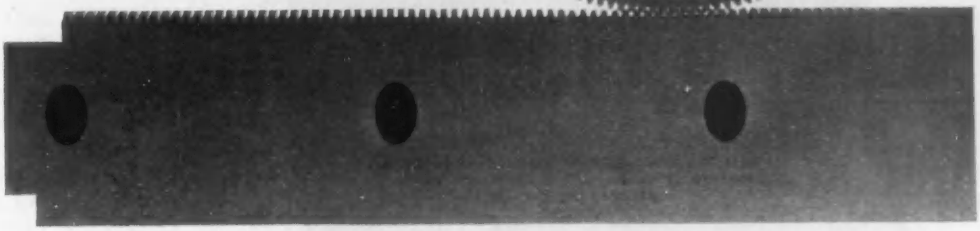
(2) RUBBER O-RING SEALS—Minnesota Rubber and Gasket Co., 3630 Wooddale Ave., Minneapolis 16, Minn. Booklet, 16 pp. Gives in detail data on the production and applications of rubber O-ring seals. Included in the booklet are sections on end products, O-ring sizes, dash numbers and variable tolerances, dimension data for installation of standard size O-rings, cross-sectional drawings of correct and incorrect installations, and methods of utilizing O-ring sealing properties.

(3) ELECTRIC ACTUATORS—Ai-Research Mfg. Co., Los Angeles 45, Calif. Catalog, 64 pp. Outlines the applications and specifications of 20 basic types of linear and rotary actuators, power units, jacks, gear boxes. Illustrated with photographs, charts and engineering drawings, the booklet is designed to help potential users choose the model that will best suit their needs.

(4) POWER TRANSMISSION EQUIPMENT—Lovejoy Flexible Coupling Co., 4945 W. Lake St., Chicago 44, Ill. Booklet 118, 22 pp. has complete information on all power transmission equipment, including: variable speed pulleys, wide V-belts,

Here's *Why* you can check precision gears *more conclusively* with Kodak Conju-Gage Gear Checkers

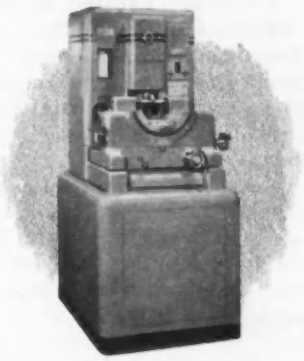




Why the composite check

Errors in gears seldom occur individually—they're usually combinations of as many as six types of errors. The practical way to test gears for these errors is to test them in action through the composite check recommended in the new American Standard (AGMA 236.02; ASA B6.11-1951).

This check measures gear errors as variations in center distance when the gear is rotated in contact with a master of known accuracy. Since this variation is the sum of errors in both gear and master, the degree of precision measurable depends on the precision of the master.



The Kodak Conju-Gage Gear Checker automatically records the composite effects of runout, base pitch error, tooth thickness variations, profile error, lead error, and lateral runout. Illustrated is the Kodak Conju-Gage Gear Checker, Model 4U, for gears up to 4½" pitch diameter. Larger and smaller models are also available.

Why the Conju-Gage Gear Checker

Kodak Conju-Gage Gear Checkers use a master of exceptional accuracy, the Kodak Conju-Gage Worm Section. These Worm Sections are generated by the continuous action of a thread grinder under control of a precision lead screw—circular pitch error and tooth thickness variations cannot be introduced by defects in an intermittent indexing mechanism. This means a more accurate gaging element, less chance that error in the master may coincide with a tolerable error in the gear to result in a needless rejection. Less chance, too, that an error in the master may subtract from an intolerable error in the gear, passing a gear that will fail in use.

By passing each right gear, rejecting each wrong gear, the Kodak Conju-Gage Gear Checker helps you reduce costs while maintaining highest precision. For the full story of this and other economies achieved by Conju-Gage instrumentation, send for the booklet, "Kodak Conju-Gage Gear Testing Principle." Write to:

Special Products Sales Division
EASTMAN KODAK COMPANY, Rochester 4, N.Y.

CONJU-GAGE INSTRUMENTATION

. . . a new way to check gear precision in action

To inspect all kinds of complex parts on a bright screen, Kodak also makes two highly versatile contour projectors.

Kodak
TRADE-MARK

tells you

why PITTSBURGH Gears will last you longer ... and cost less to use

how PITTSBURGH Gears are made in our newly equipped and enlarged plant

what Types and sizes of PITTSBURGH Gears you can get for your own use ... or in quantities to build into equipment you make

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sheaves, motor bases, counter shafts and Select-O-Speed transmission. Contains illustrations, line drawings and complete specifications for all pieces of equipment.

(5) AUTOMATIC PUMP SEQUENCE CONTROL SYSTEMS—Fischer & Porter Co., Hatboro, Pa. Catalog 91-106, 4 pp. Describes an improved automatic system for varying the number of pumps needed to satisfy fluctuating demands in multiple pump installations. Gives a detailed description of the principle of operation and has many photographs showing the equipment used.

(6) EXTRUDED PLASTIC DESIGN—Sheffield Plastics, Inc., Sheffield, Mass. Booklet, 22 pp. Shows how many rigid plastic extrusions in a two-dimensional component where continuous length is a third dimension can be produced with the facilities of this company. Shown are the design and development laboratories, the mold-making shop and other extensive extrusion facilities.

(7) SILENT CHAIN DRIVES—Link-Belt Co., 307 North Michigan Ave., Chicago 1, Ill. Catalog 2425, 88 pp. One section shows the pre-engineered stock drives for normal requirements; another section outlines the procedure for selecting completely engineered drives. This includes an index table of service factors, rating tables, and chain length and center distance compution. A section on drive components lists available chain widths, chain and wheel dimensions, wheel tolerances, materials, and other data. Complete operational and technical data such as installation, maintenance and lubrication procedures.

(8) DYNAMOMETER SYSTEMS—General Electric, Schenectady 5, N. Y. Bulletin GEA-5923, 12 pp. Discusses dynamometer systems for testing internal combustion engines, transmissions, torque converters, rear axle assemblies, pumps, fans, electric motors, compressors and other types of equipment. Tells how the systems can be used for both motoring and absorption applications.

(9) BRONZE PRECISION BEARINGS—Chrysler Corp., 6501 Harper Ave., Detroit 31, Mich. Bulletin S-53,

NEW PROTECTIVE COATING CHEMICAL FOR ALUMINUM

ALODIZING

Alodizing with "Alodine,"* a new technique in the protective coating of aluminum, was made available for production-scale use in 1946. Since that time Alodizing has largely supplanted the more elaborate, costly and time-consuming anodic treatments in the aircraft and other industries.

Continuous and successful industrial use has clearly demonstrated the simplicity and economy of the Alodizing process as well as the effectiveness of the "Alodine" amorphous coatings, particularly as a base for paint. In fact, the paint-bond that Alodized aluminum provides has been found to be superior to that possible with chromic acid anodizing.

The corrosion-resistance of unpainted aluminum Alodized with "Alodine" Nos. 100 or 300 is excellent, easily meeting the requirements of Specification MIL-C-5541. However, a need for protection of unpainted aluminum, even better than that obtained with chromic acid anodizing, has long been recognized.

NEW IMPROVED "ALODINE" DEVELOPED By ACP RESEARCH CHEMISTS

Several years of intensive research have now led to a new type of "Alodine," designated as "Alodine" No. 1200. This new protective coating chemical forms an amorphous mixed metallic oxide coating of low dielectric resistance that provides unusually high corrosion-resistance for unpainted aluminum. In addition, it forms an excellent paint bond that approaches closely the high quality obtained with the earlier types of "Alodine."

After having been tested for conformance with Specification MIL-C-5541, "Alodine" No. 1200 is now about to go into production.

PROCESS DETAILS

"Alodine" No. 1200 is the only essential chemical needed to prepare the coating bath and the final rinse bath. One of its unique features is that it can be used in tanks in an immersion process, or, in a multi-stage power washer in a spray process, or, with a slight adjustment of pH, with brush or portable spray equipment in a manual process. This means that even where the simple production equipment is not available, or where touching up of damaged coatings previously Alodized or anodized is required, excellent protection and paint bonding can still be obtained with practically no equipment.

All three methods of application easily meet the requirements of Specification MIL-C-5541.

Process sequence for all three methods of application is the same as for other standard grades of "Alodine" such as Nos. 100, 300, and 600, viz.: 1. Pre-cleaning. 2. Rinsing. 3. Alodizing. 4. Rinsing. 5. Acidulated rinsing. 6. Drying.

Coating time in an immersion process ranges from 2 to 8 minutes and in a mechanized spray process is about 30 seconds. "Alodine" No. 1200 baths are operated at room temperatures (70° to 100°F.) and heating is required only if the bath has gotten cold after a "down" period.

RECOMMENDED USES FOR "ALODINE" No. 1200

"Alodine" No. 1200 is specifically recommended for coating wrought products that are not to be painted or are to be only partially painted; and for coating casting and forging alloys whether or not these are to be painted. "Alodine" Nos. 100 and 300 are still recommended for coating wrought products such as venetian blind slats, awnings, etc., that are invariably painted.

RESULTS OF TENSILE TESTS

This new "Alodine" not only retards visible corrosion and pitting, but as shown in the table below, the loss of ductility with "Alodine" No. 1200, both brush and dip, after 1000 hours salt spray was less than for chromic acid anodizing after 250 hours, and for "Alodine" No. 100 and a conventional chromate treatment after 168 hours exposure.

PROCESS	SALT SPRAY EXPOSURE	COMPLIANCE WITH TENSILE REQUIREMENTS OF MIL-C-5541
CHROMIC ACID ANODIZING	168 hrs.	passes
	250 hrs.	passes
	500 hrs.	fails
	1000 hrs.	fails
BRUSH "ALODINE" No. 1200	168 hrs.	passes
	250 hrs.	passes
	500 hrs.	passes
	1000 hrs.	passes
DIP "ALODINE" No. 1200	168 hrs.	passes
	250 hrs.	passes
	500 hrs.	passes
	1000 hrs.	passes
DIP "ALODINE" No. 100	168 hrs.	passes
	250 hrs.	fails
	500 hrs.	fails
	1000 hrs.	fails
CONVENTIONAL CHROMATE TREATMENT	168 hrs.	passes
	250 hrs.	fails
	500 hrs.	fails
	1000 hrs.	fails

*"Alodine" Trade Mark Reg. U. S. Pat. Off.

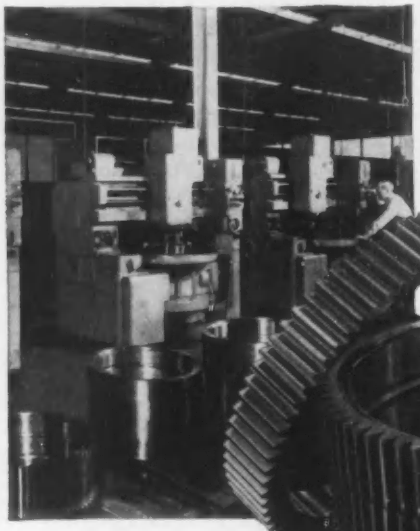
CHEMICALS ACP PROCESSES

AMERICAN CHEMICAL PAINT COMPANY

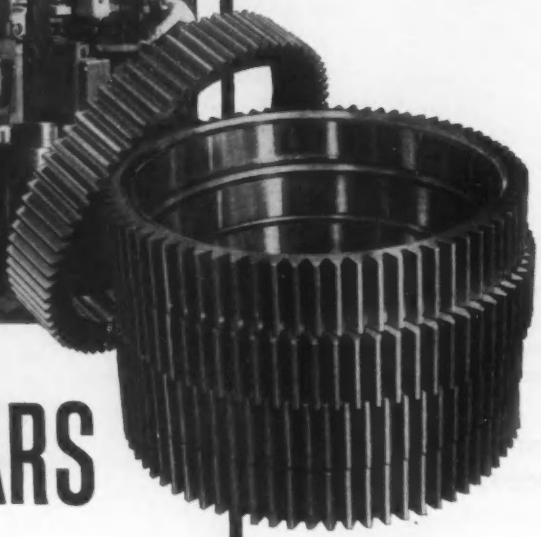
General Offices: Ambler, Penna.

Detroit, Michigan **Niles, California** **Windsor, Ontario**

● This picture shows a part of Fairfield's Spur Gear Cutting Department where finest, new equipment is used to produce gears up to 1½ pitch, 36" dia.



accuracy
economy
capacity



GEARS
by
Fairfield

AT FAIRFIELD, you get the benefit of mass production ECONOMY, combined with every modern facility for manufacturing FINE GEARS!

Here "under one roof" is everything needed to meet your most exacting gear requirements — metallurgical department, batteries of the most modern machines, testing laboratories, complete heat-treating facilities — all operated by skilled craftsmen working under expert engineering supervision.

Get acquainted with the Manufacturing Service Fairfield offers to makers of agricultural implements, road building machinery, machine tools, engines, trucks, tractors, and all kinds of powered equipment. *Your inquiry will receive prompt attention — ask for interesting, illustrated bulletin.*

FINE GEARS
MADE TO ORDER

SPUR GEARS — Straight, helical, and internal. Sizes from 16 pitch, 1½" dia., to 1½ pitch, 36" dia.

HERRINGBONE — (*Fellows Type*). Sizes from 1½" to 15".

SPIRAL BEVEL — Sizes from 16 pitch, 1½" dia., to 1½ pitch, 28" dia.

STRAIGHT BEVEL — Sizes from 16 pitch, 1½" dia., to 1½ pitch, 28" dia.

HYPOID — Sizes from 1½" to 28" dia.

ZEROL — Sizes from 16 pitch, 1½" dia., to 1½ pitch, 21" dia.

WORMS AND WORM GEARS — Worms to 7" dia. Worm gears to 36" dia.

SPLINED SHAFTS — Lengths to 52". Diameters from 1" to 6".

DIFFERENTIALS — 10,000 to 300,000 inch pounds capacity.

Note: All of the sizes above are approximate.

FAIRFIELD
MANUFACTURING CO.
2305 South Concord Road Lafayette, Indiana

26 pp. Lists more than 700 standard bearings, cores, bars and plates. The bearings are the Oilite, heavy-duty, oil cushioned, self-lubricating type. Also has graphs on: static bearing loads; dynamic load capacities; bearing clearances; and press fit valves.

(10) CONTROL CENTERS — The Clark Controller Co., 1146 E. 152 St., Cleveland 10, Ohio. Bulletin PL6200-1-1053, 26 pp. Describes the many advantages of centralized electrical control systems through the use of a-c motor control centers. Typical installations, specifications, construction details, planning tips are featured.

(11) PRECISION METAL CUTTING—Acetogen Cutting Gas Co., Inc., 20, 137 Sherwood Ave., Detroit, Mich., Booklet 20 pp. Explains the use of acetogen gas for precision metal cutting, brazing, and silver soldering. Features are: it provides fast preheating times; produces smooth cuts, with sharp edges; causes no appreciable hardening of cut surfaces; and leaves no adhering slag. Also has information on equipment used.

(12) TEFLON GASKETS — United States Gasket Co., Camden 1, N. J. Bulletin TG-953. Describes the Chemiseal gaskets and accessories for all types of chemical resistant piping and equipment. Illustrated and described are ten types of Teflon jacketed gaskets, molded Teflon snap-on gaskets for conical end glass pipe, Teflon jacketed adapters for connecting unlike nozzles, Teflon expansion joints and flexible couplings, and solid Teflon ring gaskets and special shapes.

(13) NEEDLE VALVES—Marsh Instrument Co., Skokie, Ill. Catalog NV-1, 8 pp. Contains complete engineering data for a line of needle valves having a maximum working pressure of 10,000 psi. They may be used for the fine regulation of water, oil, gas and other fluids. Has illustration of each model, and a graph showing pressure drop of various size valves.

(14) RELAYS—Advance Electric and Relay Co., 2435 North Naomi St., Burbank, Calif. Booklet 6 pp. Lists 48 relays produced by this company for a wide variety of applications. Relays shown are grouped in accordance with

their primary functions. Complete specifications such as contact rating, maximum contact arrangement, maximum coil voltage or resistance, operating power, and dimensions are given.

(15) INDUSTRIAL CONTROL MOTORS—Minneapolis Honeywell Reglator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Catalog 8203, 16 pp. Covers the complete line of industrial control motors and industrial motorized valves. Included are specifications and information for the use of industrial control motors with globe, adjustable port, butterfly valves, or combinations. Each specific unit is illustrated with complete engineering data given.

(16) PLASTIC HOSE — Resistoflex Corp., Belleville, N. J. Bulletin, 4 pp. Has information on Fluoroflex-T hose and hose assemblies, a new plastic hose made from Teflon and designed to withstand highly corrosive fluids from temperatures —100 F to +450 F. Describes test results, sizes and construction features.

(17) INDALLOY SOLDERS — The Indium Corp. of America, 60 E. 42nd St., New York City. Handbook, 60 pp. Has information on intermediate Indalloy solders, the physical properties of Indalloy solders, characteristics of various metals alloyed with Indium, and phase diagrams of Indium with other metals. Includes a number of photomicrographs, and many tables giving the properties of various Indium alloy solders.

(18) SMALL LOW TORQUE DRIVES—Warner Electric Brake and Clutch Co., Beloit, Wis. Booklet WEB-6158, 6 pp. Contains complete engineering data on the replaceable face electric brake, and a stationery field electric clutch coupling, two new units offering faster starts and stops of small low-torque drives of light machine instrument and servo drives. Features are: accurate indexing: inching and jogging; rapid cycling; and synchronized starting and stopping. Sizes of the new units range from $1\frac{3}{16}$ to $4\frac{1}{4}$ in. dia., with torque ratings from 8 to 240 lb-inches.

(19) IMPACT MACHINES—Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa. Bulletin 4211, 4 pp.

NYLOK'S Self-locking THREADED INSERTS...

• For use principally in non-ferrous forgings, castings and extrusions

CUT COSTS — because NYLOK threaded inserts eliminate counterboring, special tapping and all the secondary operations required by other threaded inserts. With NYLOK inserts, simply drill and tap with standard tools — then screw the insert in place. They give stronger, tighter fastenings which will permit fewer fastenings per application.

PROTECT PARTS — because they eliminate thread failure in expensive castings by absorbing stresses and prevent thread wear and stripping.

DOUBLE LOCK — because with the resilient nylon plug, NYLOK inserts provide a smooth, positive locking torque on both internal and external threads, thus locking the insert in the casting and also securely locking the bolt once it has been threaded into the insert.

REQUIRE NO SPECIAL TOOLS for insertion or removal. Permits use of standard screw driver. Simplifies maintenance in the field.

How NYLOK THREADED INSERTS work . . .

Resilient nylon plug (A) sets up lateral thrust on both internal and external threads, smoothly wedging mating threads together, both on casting and bolt (B) and (C). There is no galling, no thread distortion, no mutilation of mating threads. All of locking action is on threads and locking is positive. The inserts may be used and reused many times without impairing the locking feature.

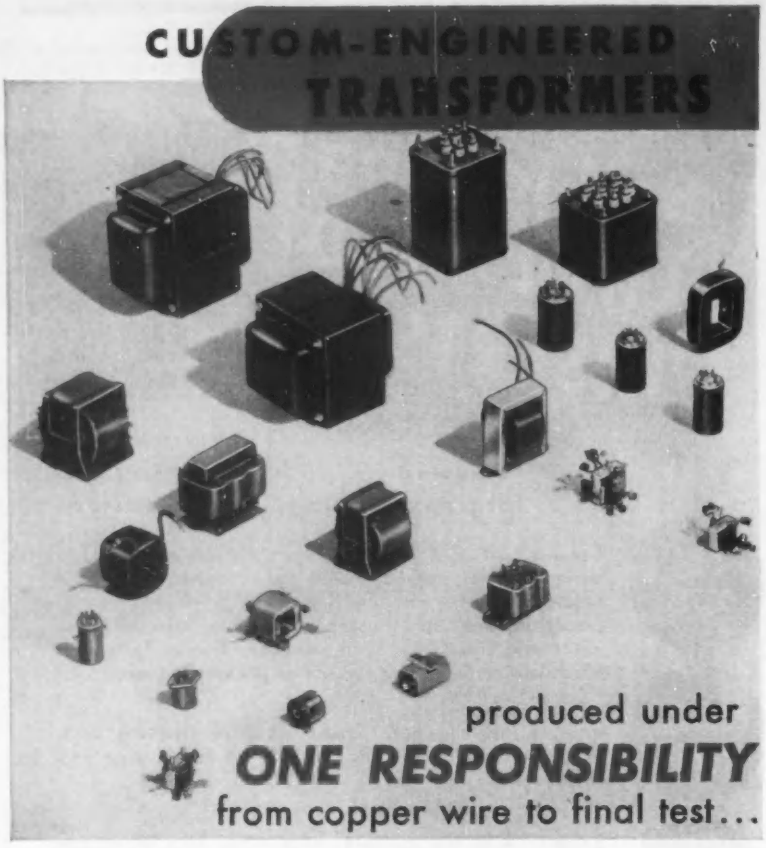
For complete details on how NYLOK threaded inserts may solve your fastening problems, write today. NYLOK engineers will gladly discuss them with you at no obligation.

THE NYLOK Corporation

Manufacturers of Nylon-Locked fasteners covered by U.S. patents and patents pending

Main Offices and Factory — Elmira Heights, N. Y.

Offices in: New York City • Detroit • Chicago • North Hollywood



- Wheeler transformers are custom-engineered to meet your specific requirements. Your needs come first with us.
- Wheeler makes its own magnet wire . . . from the copper rod to the finished, insulated and tested product . . . with quality under our control every step of the way.
- Wheeler uses the most modern winding techniques and equipment.
- Wheeler's facilities for the production of intricate coils and assemblies are unexcelled.
- Wheeler affords fullest protection to its transformers with latest techniques in wax and varnish impregnation and FOSTERITE® encapsulation.
- Wheeler transformers are subject to specially devised engineering and test procedures throughout manufacture, and must individually undergo a final comprehensive test before shipment.

To learn what these advantages can mean to you, write:

THE WHEELER INSULATED WIRE COMPANY, INC.
Division of The Sperry Corp.
1103 East Aurora St., Waterbury 20, Conn.

®The WESTINGHOUSE encapsulating material that gives a high degree of protection to small transformers. Applied by Wheeler under license.

WHEELER

MAGNET WIRE COILS
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TRANSFORMERS

WHEELER *MAKES THESE PRODUCTS A* Specialty

2WH54

Catalogs and Bulletins.....continued

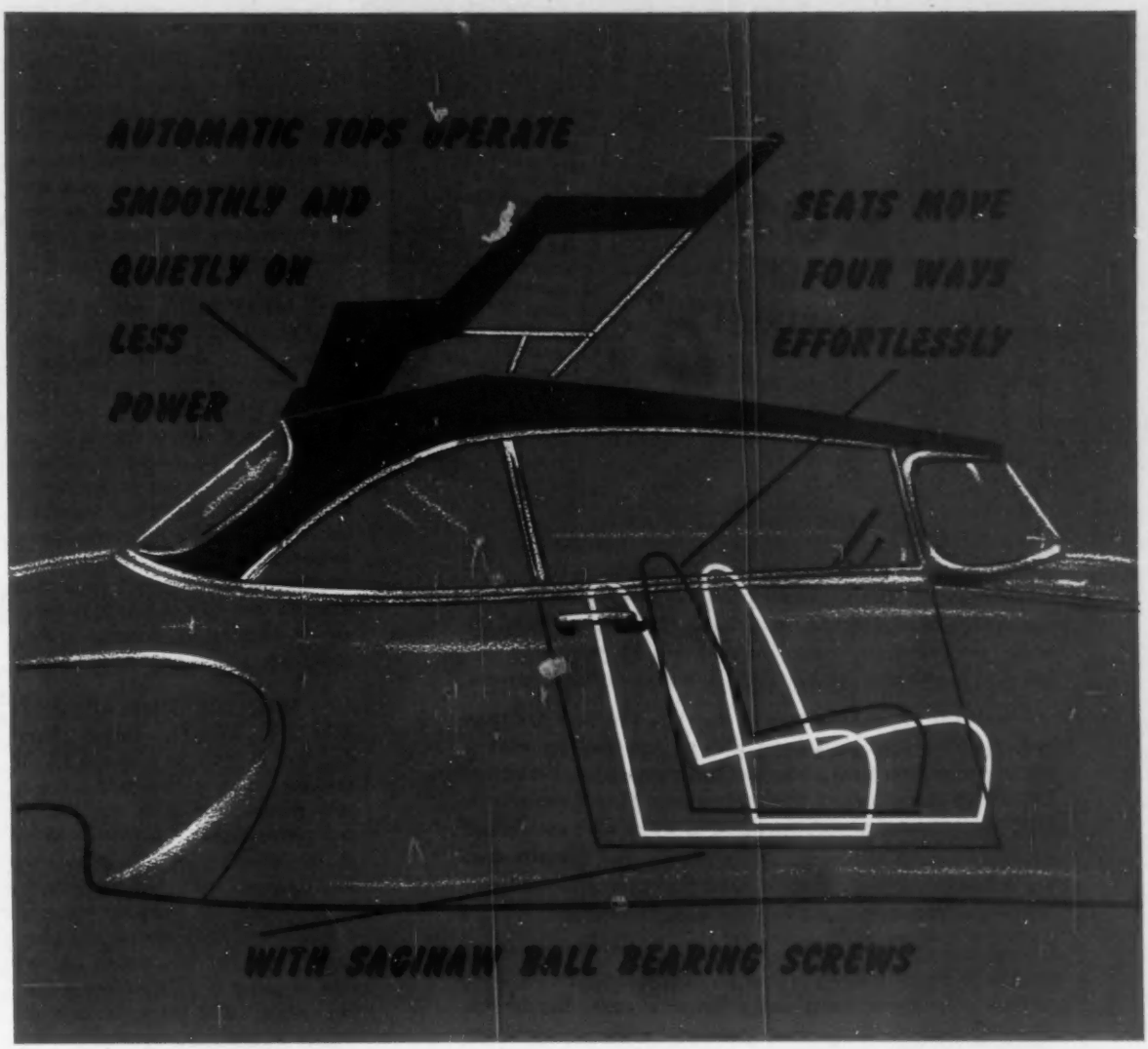
Completely illustrated, it shows various Sonntag impact machines with maximum capacities of 240 ft-lb. for metals and plastics respectively. Design features of these pendelum-type machines are illustrated, and specifications given.

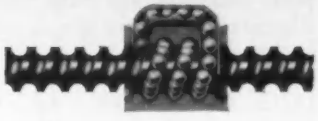
(20) BEARING APPLICATION CHART—Thompson Industries, Inc., Manhasset, N. Y. This chart was developed to permit engineers to evaluate their bearing functions with respect to 17 service requirements. Chart lists 17 basic performance and application elements to be considered in selecting bearings. Is designed so that various types of bearings may be listed and evaluated.

(21) MAGNETIC TRANSMISSION EQUIPMENT—Stearns Magnetic Inc., Milwaukee, 46, Wis. Bulletin 226-C, 8 pp. Provides a ready reference for figuring the right transmission equipment for individual applications, and contains complete figures, diagrams, dimensions, capacities, horsepower and torque ratings on clutches, brakes, and clutch-brake combinations.

(22) SYSTEMS ENGNEERING—Glenn L. Martin Co., Baltimore 3, Md. Catalog, 38 pp. Describes the philosophy of systems engineering as a basic idea for integrating all of the engineering departments behind the design of one product. Describes the overall engineering organization, the design and development department, projects department, the aerodynamics department, structures department, electromechanical, electronics, and the production design department. Schematic diagrams show the operations of these departments. Included are a number of photographs and information on the various planes built by Martin.

(23) WORM GEAR SPEED REDUCERS—The Cleveland Worm & Gear Co., 3271 E. 80th St., Cleveland 4, Ohio. Catalog 400, 174 pp. Presents in a compact and usable form a catalog showing in complete detail how to select speed reducers for any specific purpose. It is divided into many sections, some of which are: Why Worm Gear Speed Reducers?! Worm Gear Design; Ratings of Standard Single Reduction Units; Efficiency Curve; ratings of Double Reduction Units; Dimension Sheets; Cooling





It takes very little battery power to operate the new four-way seat adjustment or to raise and lower the new quiet-operating automatic tops when Saginaw Ball Bearing Screws actuate the mechanism. These highly efficient screw assemblies transmit the rotary to linear force through rolling steel balls with less than 10% friction loss, thereby reducing the torque requirements to operate the mechanism. Saginaw Screws are also very effective in heavy duty applications like machine tools and in precision applications such as aircraft controls. Depending on the type of application, Saginaw Screws can cut power requirements as much as ⅓ and improve the performance of your product as well. Write today for our engineering data book giving you complete information.

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68

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AND it might well be yours! For if you are now buying the components for servo systems from several manufacturers, you are probably wasting time, labor, machinery, and material, modifying the various units for better coordination. And you still end up with only the inferior performance that such a hodge-podge delivers.

Transicoil experience proves that you can save the time and trouble of secondary operations and end up with a better system by merely using assemblies made up of matched Transicoil components. The units comprising these assemblies are designed and constructed to work with each other for optimum efficiency, top performance, and actually cost less when assembled than the total purchase price of individual components acquired from several sources.

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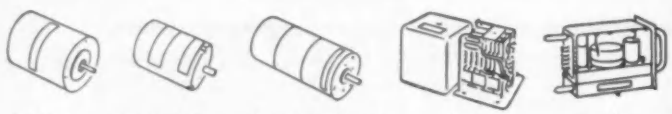

Miniature Control Motors | Motor and Gear Train Assemblies | Motor, Generator, and Gear Train Combinations | Servo Amplifiers | Plug-In Assemblies

Tower Drives; Fan Cool Units; Special Unit Designs; and Standard Components for Built-In Drives. Has many illustrations of all the types produced with rating tables for each, plus many graphs. A number of cut-away views are shown along with close-up views of specific parts.

(24) MEASURING, INDICATING INSTRUMENTS — Schaevitz Engineering, P. O. Box 505, Camden 1,, N. J., Booklet, 8 pp. Illustrates and describes a line of measuring, indicating, recording, and control devices for use in many different industries. Included are: linear and angular accelerometers; linear variable differential transformers; rotary variable differential transformers; pressure transducers; rotary accelerators; and others. A detailed description goes with each as to its varied use. In addition line drawings to show application are included in many cases.

(25) POSITIVE DISPLACEMENT ROTARY PUMPS—Tuthill Pump Co., 939 E. 95th St., Chicago 19, Ill. Presents complete data on this line of gear pumps, and gives specifications and performance characteristics to aid in the selection of the pump best suited to the individual requirement. In describing the pumping principle, it has several cross-section and phantom views. The information on each type of pump is presented in a separate section listing the service to which it is best suited, the capacity, packing, pump mountings, and pump features. Illustrations are shown of each model.

(26) MINIATURE MOTOR PRODUCTS—Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio. Describes an extremely small permanent magnet d-c motor, specifically designed for precision airborne accessory equipment. It also has been adapted to a variety of additional applications where a motor of high power is required in a minimum of size and weight. The various units for which complete engineering specifications are given are: blowers, fans, servos, gear units, governors, motor switches, vibrators, and gyros.

(27) HEAVY DUTY AIR CYLINDER—Petch Mfg. Co., Alpena, Mich. Booklet, 10 pp. Describes a line of automotive air cylinders for heavy-duty use on conveyors, in foundries, on

welding equipment, automation, and other automatic machinery. Gives complete specifications and dimensions for the various type cylinders on the following mounts: foot, clevis, trunion, rod end flange mount, and blind end flange mount.

(28) LUBRICATORS — Madison-Kipp Corp., Madison 4, Wis. Bulletin L-3401, 8 pp. Shows a variety of new lubricating units with a pumping principle based entirely on registering ports. The unit is valveless, but positive metering is obtained by oscillating ported plungers. Each unit may be adjusted to deliver from a fraction of a drop to ten drops per impulse. Units are available with ratchet, rotary, or direct drives.

(29) SMALL VERTICAL PUMPS—Allis-Chalmers, Milwaukee 1, Wis. Gives complete construction details and has many graphs showing the pumping capacity of the various models of pumps. Also has a number of charts such as those giving the motor frame table, friction of water in pipes, and resistance of fittings to flow of fluids.

(30) VARIABLE SPEED DRIVES—Link Belt Co., 307 N. Michigan Ave., Chicago 1, Ill. Catalog 2274, 90 pp. In great detail it discusses the following aspects on a line of positive infinitely variable speed drives: the operating principles, construction and types; preselecting drives; typical drive arrangements; ratings and engineering data; assemblies; dimensions; accessories; controls; automatic controls; sectional diagrams; and a section on how industry uses these variable speed drives to best advantage. Has many illustrations showing the construction features and the complete line of drive units available.

(31) SINGLE AND POLYPHASE MOTORS—Brook Motor Corp., 3555 W. Peterson Ave., Chicago 45, Ill. Booklet 1253, 6 pp. Describes a line of alternating current motors available in two principle classifications; single-phase capacitor type, and polyphase squirrel cage motors. Each of these groups include the four major types: open drip-proof motors; splashproof motors; totally enclosed non-ventilated motors; and totally-enclosed externally fan-cooled motors. A complete

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Now in Production The new BALDOR Baltric motors—smaller NEMA frames • more horsepower • less weight • streamcooled • totally enclosed • high performance • cool operation • simple design • compact contour rugged construction • protected ball-bearings • polyphase and single phase • integral and fractional ratings.

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BALDOR BALTRIC MOTOR
3-phase and single phase

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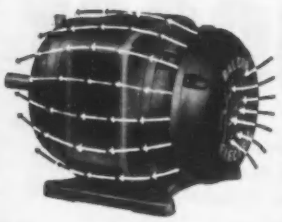
TOTALLY ENCLOSED

STREAMCOOLED MOTORS

REQUIRE *Less* SERVICING

BALDOR STREAMCOOLED Motors are solidly enclosed, cooled by an outer-mounted fan in the bell-end. They cannot inhale dust, dirt, grit or metal particles. They require no dismantling for cleaning thus LESS servicing—no interruption of production.



Other features of BALDOR Motors include sealed ball-bearings which can be re-lubricated without removing end-plates. Corrosion-resistant inside and out. End plates interchangeable for vertical or bracket mounting. Each motor individually dynamically balanced. Standard NEMA dimensions.

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listing of standard and special types is shown in a selection guide which contains electrical features and mechanical features. A large cut-away view shows construction features.

(32) SOLENOID VALVES — J. D. Gould Co., 730 E. Washington St., Indianapolis 2, Ind. Bulletin 500, 4 pp. Illustrates and describes a complete line of solenoid valves for automatic or remote control of steam, air, gas and liquid flow. Described are 25 types of solenoid valves with details on their applications, operations, specifications, design and construction. Models range in size from ¼ to 3 in., and handle pressures up to 1200 psi (steam to 150 psi).

(33) AIR OPERATED CLUTCHES AND BRAKES — Industrial Clutch Corp., Waukesha, Wis. Bulletin 5005, 4 pp. Describes an improved series of LK (low kinetic energy) type clutches for any machines where a fast cycle and accurate stopping are essentials. Low power losses in starting and stopping and a high heat dissipating capacity permit the clutches to function in duty too severe for ordinary friction clutches. Booklet explains the design, the low inertia, the air operation, the spring-loaded brakes, and the construction of the clutches and brakes. Has several illustrations and a chart giving all the necessary information for the various sized models.

(34) INSTRUMENTS CATALOG—Electro-Tech Equipment Co., 308 Canal St., New York 13, N. Y. Catalog 54, 190 pages. A comprehensive catalog, it is divided into 10 sections and covers the following subjects: laboratory and portable test instruments; bridges, decades and recording instruments; panel and switchboard instruments; pyrometers, thermometers and associated equipment; service instruments; transformers, voltage regulators, rectifiers and controls; timers, counters and photoelectric controls; heaters, furnaces and accessories; switches, relays, solenoids, and solenoid valves; and miscellaneous equipment. Each item is illustrated with complete specifications given for each.

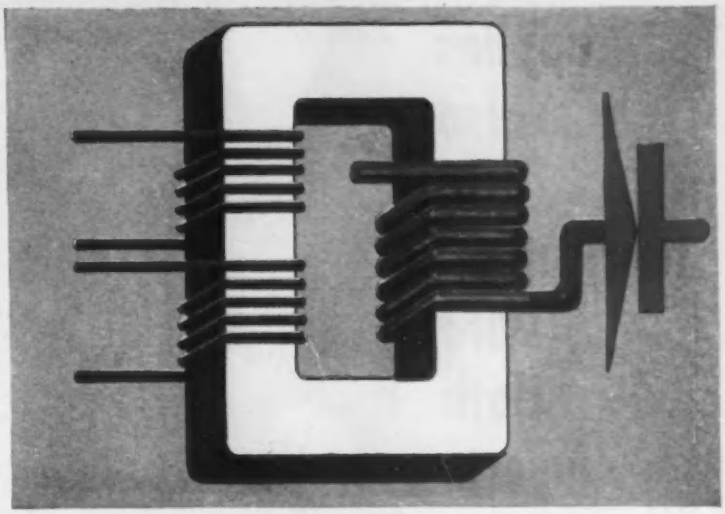
(35) SMALL LAMP SOCKETS—The Dialight Corp., 56 Stewart Ave., Brooklyn 37, N. Y. Booklet L-154, 22 pp. The bracket-mounted sockets

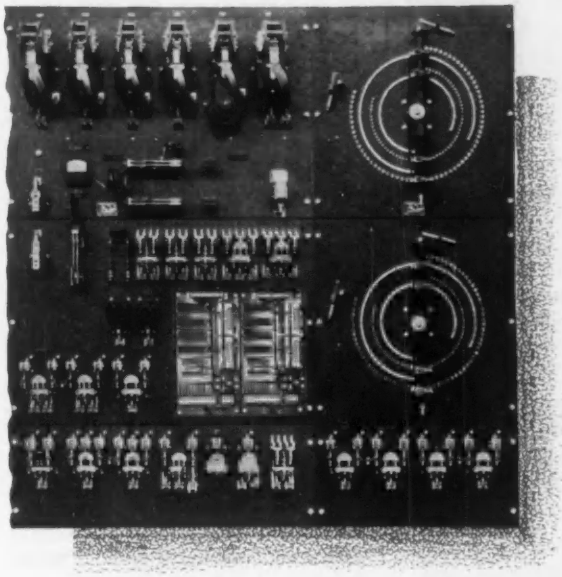
CLARK *Magnetic Amplifier*

regulates without tubes or moving parts

The CLARK Magnetic Amplifier has the ability to amplify a small signal current, thus making it ideal for service in voltage regulation, speed control, positioning, tension control and accelerating applications.

Built like a transformer, with no moving parts or tubes, it is unaffected by shock and vibration. It requires no warm-up period and practically no maintenance. It is rugged and reliable, and does not get out of adjustment.





The picture shows CLARK Magnetic Amplifiers applied to Motor Operated Rheostats. No contacts are required in the motor circuit to reverse rotation. Pre-selected positions on the rheostats are provided by Push Button and Potentiometer remote control, or combinations of any desired number.

Within a range of 5 to 20 seconds, any selected rate of travel in either direction is available. There is continuous adjustment of position, and the speed of response prevents hunting or overshooting. Accuracy is maintained within one button on the Motor Operated Rheostat.

The power requirement is very low.

Greater production, finer performance and more uniform operation in a broad variety of applications in industry result from the use of CLARK MAGNETIC AMPLIFIERS.

Write for your copy of "Magnetic Amplifier Applications for Modern Industry," or call your nearest CLARK representative.

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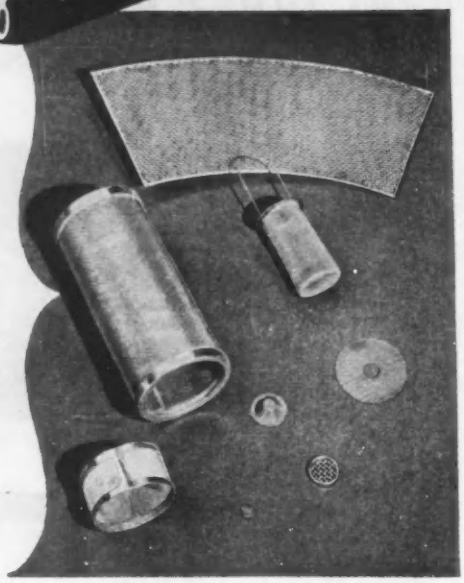

Our slogan, Newark for Accuracy, has long been known to users of bulk wire mesh cloth, wire space cloth and wire filter cloth. It is now becoming more and more familiar to users of parts fabricated from wire cloth made by a fast-growing division of our company.

These parts, similar to those illustrated, are fabricated or assembled for our customers by skilled workmen in our large department specializing in this work. We are equipped to handle small lots or in production quantities of anything from large jet intake screens to tiny fuel pump strainers.

We shall be glad to quote on your requirements; and, if necessary, our experienced engineers stand ready to assist you in the design of the part so as to make the best use of the mesh and to assure the most economical manufacture of the part as a whole.

Remember, since we weave the cloth used, and do all the necessary cutting, fitting, stamping, punching, forming, binding, welding and soldering, there is only one responsibility . . . OUR responsibility . . . to deliver parts that live up to our slogan — Newark for Accuracy.

We can furnish wire cloth woven from all commercially used metals. Sizes range from 4 inches (space cloth) to 400 mesh.

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY

are divided into two groups: soldering terminals, and those with wire leads. The units described fall into the following groups: (1) Double contact bayonet base with wire leads for bakelite or ceramic disks; (2) Candelabra and intermediate screw with soldering lugs; (3) Candelabra screw with soldering terminals or wire leads; (4) Miniature screw with soldering terminals; (5) Miniature bayonet with soldering terminals or wire leads. For each particular group of sockets a choice of 12, 14, or 15 basic types of mounting brackets are illustrated. Navy specification sockets are also illustrated and described.

(36) OIL HYDRAULIC CYLINDERS—Pathon Mfg. Co., Cincinnati 12, Ohio. Bulletin 22, 32 pp. Has information on a new line of oil hydraulic cylinders and hydraulic directional control valves. Gives complete information on various models including tables of sizes and engineering information. Has many illustrations, charts and several nomograms.

(37) TIME DELAY RELAY—Elastic Stop Nut Corp. of America, Elizabeth 3, N. J. Bulletin SR 5, 4 pp. Describes a new hermetically sealed time delay relay which measures $2\frac{1}{8}$ x $2\frac{5}{32}$x$3\frac{7}{8}$ in. and weighs only 1.2 lb. It meets military requirements for vibration, shock, acceleration, temperature resistance, and is unaffected by voltage variations. Sealed against dust and moisture. Length of time delay is externally adjustable over a range from 0.030 to 120 sec. Includes mechanical and electrical specifications, wiring diagrams, and mounting dimensions.

(38) BERYLLIUM COPPER SPRINGS — Instruments Specialties Co. Inc., Little Falls, N. J. Catalogs 8 and 8A, 24 pp. Catalog 8 illustrates a wide variety of custom-made beryllium copper springs used in electrical and mechanical application. Physical properties of beryllium copper are shown as well as many helpful suggestions on spring design. Catalog 8A describes a variety of beryllium copper components designed specifically for use in the electronics industry. Complete engineering specifications are given for all items.

(39) FITTINGS & PIPING HANDBOOK — Ladish Co., Cudahy, Wis.

Handbook, 304 pp. Gives detailed dimensional data and specifications on a complete line of controlled quality seamless welding pipe fittings, forged ASA flanges, large diameter and TEMA flanges, as well as screwed and socket welding fittings. Catalog includes a 56-page technical data section featuring new easy-to-use allowable stress and P/S tables, maximum allowable working pressure charts, as well as many other tables covering flow through orifices, properties of saturated and superheated steam, friction loss, properties of pipe, pressure-temperature ranges, and dimensional tolerances of fittings and flanges.

(40) MACHINE TOOL LIMIT SWITCH—Square D Co., 4041 North Richards St., Milwaukee 12, Wis. Booklet SM-239, 14 pp. Describes the new Class 9007 Type T heavy-duty oil type machine tool limit switch, offering simple adjustment, eleven contact arrangements; and 80 deg. overtravel. Has illustrations of all models, giving electrical ratings and other necessary engineering data.

(41) CAMS, CAMSHAFTS, & CRANKSHAFTS — The Meehanite Metal Corp., 714 North Ave., New Rochelle, N. Y. Bulletin 39, 12 pp. Well-illustrated booklet is devoted to the application problems solved by Meehanite cams, camshafts and crankshafts. In addition it describes briefly the basic metallurgy and the important engineering properties of a few of the types of Meehanite metal widely used for such service.

(42) AIR CYLINDERS—The Fluid Power Co., 2040 N. Hawthorne Ave., Melrose Park, Ill. Bulletin A-105G, 8 pp. Describes a line of 200 psi nonrotating air cylinders featuring hard chrome-plated piston rods, dirt wiper seals, rustproof brass barrels, and solid steel heads, caps, and mountings. Has many line drawings showing construction, also a number of charts giving complete dimensions and specifications. One large cross-sectional view shows the construction features.

(43) GAGES AND THERMOMETERS—The James P. Marsh Corp., Skokie, Ill. Catalog 76-G, 80 pp. Has information on the following types of gages: altitude; ammonia; combination; compound; compound retard;

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The VARD ball screw is an efficient, accurate and reliable mechanism. When combined with electric, hydraulic or pneumatic power units these ball screws provide the most efficient known means for transmitting rotary to linear motion.
Engineering inquiries for information concerning specific applications should be directed to the VARD sales department.
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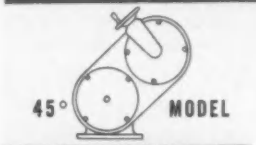

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1 New redesigned, more compact drive gives you speeds from 3 to 4660 RPM . . . speed ranges from 10 to 1!

2 New "all-position," 14-turn handwheel gives operator sensitive, minutely-accurate speed control from a position most convenient for the installation!

3 New "all-position" output shaft permits driving in any direction—horizontal or vertical-down!

4 New spiral groove lubrication with exclusive overflow outlet provides complete lubrication of all sliding surfaces for trouble-free operation at all times!

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double-spring pressure; duplex pressure; Freon; gages with corresponding temperature scale; hydraulic gages; ounce graduated retard gages; pressure gages; also sprinkler, syphon, test, and vacuum gages. The thermometers described are dial, recording, pocket and freezer type. A section is devoted to a line of accessories. Each gage and thermometer is illustrated and a brief description is included.

(44) MOTOR CONTROL — Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 4, Wis. Catalog 120 pp. Apparatus described is direct current apparatus, drum switches, rheostats, speed regulators, alternating current manual starters, alternating current magnetic starters, pushbutton limit switches, accessories and synchronous starters. Many components that fall into these categories are illustrated and complete specifications are given.

(45) CENTRALIZED LUBRICATION — Alemite Div. of Stewart-Warner Corp., 1826 Diversey Parkway, Chicago 14, Ill. Booklet 22-189, 16 pp. Describes three types of systems to serve every need, the Type 0, Type 1, and Type 2 Accumeter System. The Type 0 System is designed for lubricating with oil at a minimum temperature of 50 deg. F. The Type 1 system is designed for the dispensing of all fluid oils and light greases. The Type 2 system is a fully hydraulic system designed for the dispensing of all pumpable oils or greases, especially adaptable for large machines or for groups of machines. Can be installed indoors or outdoors. Applications are given for the three types of systems with principle of operation, application data and specifications.

(46) INVESTMENT CASTINGS— Vascoloy-Ramet Corp., Waukegan, Ill. Booklet, VR-470, 8 pp. Gives some typical small parts problems of intricate form, wear resistance, corrosion resistance, heat resistance and oxidation resistance, and shows how these problems are solved by the investment casting process. Also illustrates parts requiring non-machinable materials that can be investment cast. Facilities in engineering services available are outlined.

(47) FLEXIBLE COUPLINGS — Lovejoy Flexible Coupling Co., 4945

THE VALVE THAT REVOLUTIONIZED AIR CYLINDER OPERATION

You are looking at a cut-away section of the air control valve that has made air cylinder history — the Bellows Electroaire Valve. It, as much as any single factor, has been responsible for the terrific growth in the use of pneumatic circuits in production processes in the past ten years.

Why? - First of all — it is a complete air control unit. Not only does it direct the high pressure air to the desired cylinder port *instantly, without lag,* but it regulates and controls the speed of the air cylinder piston.

Second - while electrically controlled, it is not electrically powered. Instead of using heavy power solenoids to shift the valve, it uses the air it controls to do the work. Two sealed solenoids, hardly bigger than a thimble, act as "triggers" to release and direct the high pressure air.

Third - the small sealed solenoids act on only 8 volts of current. There is no danger of solenoid burnout (in fact the control units are guaranteed against burnout). Wiring requirements in interlocked circuits are simple. There is no electrical hazard to either operator or machine.

Fourth - the Electroaire Valve is compact. No bigger than a package of king-size cigarettes, it fits into crowded quarters, or on moving machines.

And finally — the Electroaire Valve is durable. Over a quarter of a million are in everyday use. Records of 30,000,000, 40,000,000 even 50,000,000 cycles without repairs of any kind are common.

Of course, the Electroaire Valve is a built-in feature of all electrically-controlled Bellows Air Motors, but it is equally suitable for use with any conventional air cylinder up to bores of 4½" - 5".

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Bulletins EV-310 — and CL-50 — detailed information on the Bellows Electroaire Valve and other Bellows "Controlled-Air-Power" Devices. Address:
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CONTROLLED-AIR-POWER FOR FASTER, SAFER, BETTER PRODUCTION

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SOCKET SCREW PRODUCTS
The reason why more and more users of socket screws are turning to Blue Devil is that they know they get exactly what they want . . . and exactly when they want them. Better see your Blue Devil distributor for the full story!
CAP SCREWS
"Diagonal Knurled" heads (for ½" diameter and smaller) assure easier hand assembly.
SET SCREWS
Supplied with ground threads thru ⅜" dia., where screw length equals or exceeds diameter. Six point styles.
FLAT HEAD CAP SCREWS
Flush countersink type. Tamper-proof. Eliminate slot stripping.
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Precision die cut threads assure an excellent dry seal.
STRIPPER BOLTS
Accurately ground body diameters, undercut to permit tightening flush to shoulder.
SOCKET SCREWS EXCLUSIVELY!
Actual cross-section diagram shows how cold forming of Blue Devil socket head insures unimpaired fiber continuity.
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West Lake St., Chicago 44, Ill. Bulletin 1009, 20 pp. Illustrates a line of flexible couplings, giving specifications, dimensions, operating capacity, horsepower and rpm. Types described are: the Type L one-piece spider cushion; Type C individual load cushions; Type H heavy-duty individual load cushions; Type CF flange-mounted; Type CIF hub mounted; and Type CQ, HQ removable jaw rings for radial removal or independent rotation. Also shows the various materials used for the cushions, has several charts and a horsepower-to-torque conversion table.

(48) FRACTIONAL HORSEPOWER GEARS — Gear Specialties, Inc., 2635 W. Medill Ave., Chicago 47, Ill. Booklet, 6 pp. Shows the many types of small gearing available. Included with illustrations are: armature shafts; spiral bevels; combination gear trains; spur and helical double reduction; worm and gear; intervals; helicals; spurs; ratchets; spring loaded and compound gears; bevels; and cams and ratchets. Included is a diametral and a circular pitch table.

(49) CLOSE COUPLED PUMPS—Allis-Chalmers, 1002 S. 70 St., Milwaukee, Wis. Bulletin 52B6083B, 6 pp. Complete engineering data on a compact general purpose pump with capacities to 2,500 gpm, heads to 550 ft, and temperature to 250 F. Features: choice of packing or mechanical seal; available in a choice of materials; easy installation and maintenance. Has large cutaway diagram with all parts identified and illustrations of sealing arrangements.

(50) ROLLER BEARING UNIVERSAL JOINTS—Borg-Warner Corp., 2026 Harrison Ave., Rockford, Ill. Catalog GI-50, 90 pp. It is divided into the following sections: General Engineering Data; the type RA, which consists of the roler bearing universal joints for wide angle operation on farm and industrial machines; tubular products, which contains, rollers and propeller shafts for farm machines; the type C which covers roller bearing universal joints for industrial applications; the type R aircraft which covers roller bearing universal joints. Has many photographs, line drawings and charts giving detail engineering data for the many sizes.

MEETINGS

May 7-8

INSTITUTE OF RADIO ENGINEERS—North Atlantic Region Convention & Exhibit, Sheraton Plaza Hotel, Boston, Mass. The latest developments in electronic equipment and components will be displayed by about 100 companies and representatives. Papers will be on "Transistors, Application & Further Development," "Tinkertoy Techniques" and others.

May 8-14

AMERICAN FOUNDRYMEN'S SOCIETY—Convention and Exhibit, Public Auditorium, Cleveland Ohio.

May 17-19

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—Morrison Hotel, Chicago, Ill. A meeting for the men and women who make, test, market, and use electrical appliances in the home. Will include panel discussions and technical papers on appliance problems.

May 17-20

BASIC MATERIALS EXPOSITION—International Amphitheatre, Chicago, Ill. Values of different materials can be discussed and related to each other. Seventeen specialists will lead conference discussions. One principal topic will be "Peacetime Uses for High-Temperature Materials Developed for Rockets and Guided Missile." Only materials will be shown—no machinery.

May 24-26

NATIONAL TELEMETERING CONFERENCE—Hotel Morrison, Chicago, Ill. Under the joint sponsorship of the Institute of Radio Engineers, the American Institute of Electrical Engineers, the Institute of The Aeronautical Sciences, and the Instrument Society of America. Offers material of wider scope as a result of missile telemetering and remote control information recently developed.

May 31

CANADIAN INTERNATIONAL TRADE FAIR—Toronto, Canada. Twenty-six countries are represented with exhibits, and products to be displayed range from ceramics to machine tools and

. . . for the HIGHEST QUALITY in Sanitary Stainless Steel Fittings • Valves • Pumps and Tubing . . .

Compare these fitting features . . .

- FABRICATED FROM TOP QUALITY STAINLESS STEEL
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For *one* quality source of supply for *all* your sanitary line requirements, be sure to specify TRI-CLOVER. See your nearest distributor.

For "C-I-P" LINES—Tri-Clover offers the complete "TRI-CLAMP" line of fittings and valves, for cleaned-in-place installations. Sizes from 1½" through 4" O.D., simple, fast and economical to install.

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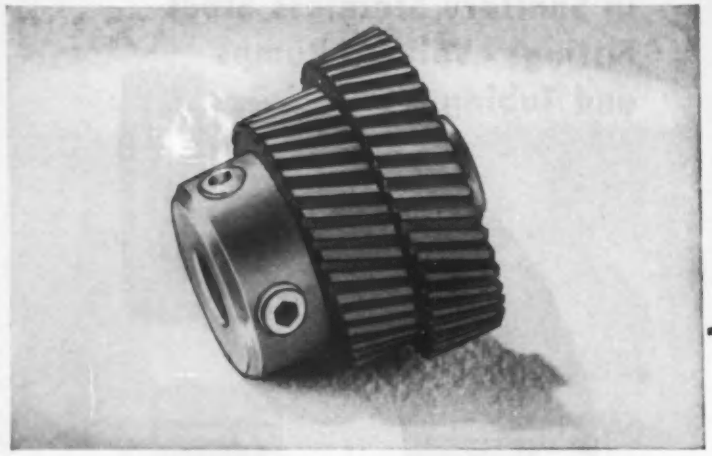
TRIALLOY AND STAINLESS STEEL SANITARY FITTINGS, VALVES, PUMPS, TUBING, SPECIALTIES

FABRICATED STAINLESS STEEL INDUSTRIAL FITTINGS AND INDUSTRIAL PUMPS

THE Complete LINE



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CAN SAVE YOU UP TO 90% ON GEAR COSTS . . . . .

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FOR over a decade we have been manufacturers of fine pitch gears. In this we are serving some of America's most particular users of precision and commercial gearing.

Now we have added a completely equipped department for producing Nylon Gears. Because of our past experience and our facilities, we are a logical source for Nylon Gears. We can mold large quantities at savings up to 90%. We can cut smaller quantities from molded blanks at definite savings. We can produce experimental work cut from Nylon bars.

A Nylon Gear can mate with a metal gear —we can make both—and be responsible for the performance of both. Benefit by our KNOW HOW to SHOW HOW Nylon Gears can be adapted to your use.

When you think of GEARS . . . in any material . . . think of GEAR MEN

PG

PROCESS GEAR CO., INC.

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power plants; this will include precision electronic instruments, balancing machines, ball bearings, lubricants, welding equipment, and many others.

June 7-10

NATIONAL PLASTICS EXPOSITION—Public Auditorium, Cleveland, Ohio. Sponsored by the Society of the Plastics Industry. All phases of plastics manufacture will be represented—molding, lamination, extrusion; fabrication; reinforced products; film, sheeting, and coated fabrics, raw materials; machinery; and testing and research.

June 9-11

AMERICAN SOCIETY FOR QUALITY CONTROL—Jefferson Hotel, St. Louis, Mo. The program will consist of 72 sessions, which will include 67 technical sessions and 5 sessions devoted to plant tours. The chemical and textile divisions, as well as the aircraft, automotive, electronics, metals, and operations research committees are participating.

June 13-18

AMERICAN SOCIETY FOR TESTING MATERIALS—Sherman and Morrison Hotels, Chicago, Ill. The 11th exhibit of Testing and Scientific Apparatus and Laboratory Supplies and the 9th Technical Photographic Exhibit.

June 14-18

THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION'S 62ND ANNUAL MEETING—University of Illinois, Urbana, Illinois. Over 2,000 people are expected to attend the banquet, four general sessions and 80 conferences.

June 15-25

MASSACHUSETTS INSTITUTE OF TECHNOLOGY—Cambridge, Mass. A special summer program to review developments in machine tool technology. Some subjects: machine tool requirements, vibrations and their isolation, machine tool controls, lubrication, quality control, and others.

June 16-18

HIGH VACUUM SYMPOSIUM—Berkeley Carteret Hotel, Asbury Park, N. J. Sponsored by the Committee on Vacuum Techniques, the following subjects will be discussed in technical sessions: nomenclature & standards; new equipment; fundamental developments; and methods.

DESIGN and PRODUCTION NEWS

FOR PLASTICS AND MATERIALS ENGINEERS

Published by TECHNICAL SERVICE, Chemical Manufacturing Division, The M. W. KELLOGG Company APRIL-MAY 1954

Kel-F® Keeps Jet's Fuming Nitric Acid Line Secure Under Severe Minus 65 to +165°F Cycling

Fuming nitric acid vapor, operational shock and thermal cycling can't loosen the grip of these special lock nuts fitted with inserts of "Kel-F" plastic.

Viciously corrosive fuming nitric acid cannot attack chemically-inert "Kel-F". Once tightened, nuts remain tight, in spite of sub-zero to 165°F variations of temperature, because of the dimensional stability of the plastic inserts. Engine vibrations or accidental blows won't crack or weaken the "Kel-F" which has exceptional impact and compressive strength. Exposure to moisture doesn't affect the plastic's form or properties . . . preventing failure from swelling, shrinkage or softening.

The Elastic Stop Nut Corporation of America, Union, N. J., produces these fasteners using corrosion-resistant alloys with inserts injection-molded from "Kel-F" polymer Grade 300 (unplasticized). Elastic Stop* nuts with "Kel-F" are produced in sizes from #10 to 3/8", with jet and rocket manufacturers listed as major users.

For further information ask for Application Report C-114

*Trade-Mark Elastic Stop Nut Corporation of America

Magnetic Stirring Bars Sealed in Kel-F® to Stop Corrosion and Breakage

A vacuum-tested casing of "Kel-F" permits these metal bars to be used indefinitely to "mix" highly corrosive acids, alkalis, solvents and peroxides—at from minus 200°C to plus 200°C—without corrosion or breakage. The fluorocarbon "skin" cannot crack or chip. Non-porous and non-absorbent, the covering is virtually self-cleaning, can even be sterilized.

Three sizes of stirring bars are now made by the Arthur H. Thomas Company of Philadelphia, Pa., by sealing cylindrical permanent magnets into extruded tubing. Extruded from unplasticized "Kel-F" Grade 300 by the Plax Corporation of Hartford, Conn.

For further information ask for Application Report C-115

® *Registered trademark for The M. W. Kellogg Company's trifluorochloroethylene polymer products.*

(SEE REVERSE SIDE)

CONTINUED FROM PRECEDING PAGE

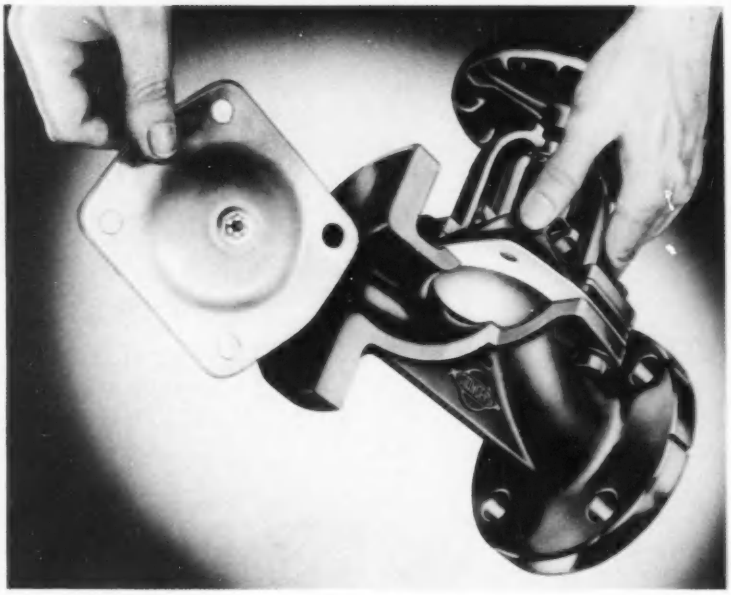
Saunders Valve Diaphragm of Kel-F® Controls Aromatics, Ketones at 230°F ...Cuts Maintenance Costs

Greatly increased diaphragm life and a sharp reduction in valve maintenance resulted when Grinnell-Saunders valves handling active organics were equipped with diaphragms of plasticized "Kel-F". Diaphragms have remained flexible, "sticking" has been eliminated and positive fluid control maintained.

"Kel-F" was specified because of its known inertness to practically *all* chemicals, even at elevated temperatures. The diaphragm retains its flexibility, being plasticized with chemically resistant "Kel-F" polymer oils.

Valve diaphragms, with imbedded metal studs, are compression molded from Grade 300 P-25 (25% plasticized) "Kel-F" polymer by the Chicago Die Mold Division, United States Rubber Company, Chicago, Ill. Diaphragms of "Kel-F" are used in thickness from .040" to .090" by the Grinnell Company, Providence, R. I., in Saunders-Type valves of ½" to 8" capacity.

For further information ask for Application Report C-116



Molders & Fabricators of the Month

Leading molders, extruders and fabricators specialize in the production of materials and parts made of "Kel-F"... each month this column will spotlight several of these companies with their principal services and products.

Brilhart Plastics Corporation
Mineola, N. Y.
Injection, Compression & Transfer Molding
Electrical & Electronic Components
Gaskets, Diaphragms & "O" Rings

Fluoro Plastics, Incorporated
Philadelphia, Pa.
Compression & Transfer Molding
Gaskets & "O" Rings; Valve Seats; Containers
Electrical & Electronic Components

The Garrison Company
Kenilworth, N. J.
Extrusion & Production Machining
Electrical & Electronic Components
Wire Insulation

Penn-Plastics Manufacturing Co.
Glenside, Pa.
Compression & Transfer Molding
Electrical & Electronic Components

Porous Plastic Filter Company
Glen Cove, N. Y.
Porous Filters

Recent Significant Developments in "Kel-F"

Electronic Tube Caps boost performance of high-altitude communications equipment, removing interference from thermal cycling, high humidity.

Asbestos, Glass Fiber, other fillers being successfully incorporated in molded parts in high temperature, corrosive valve service, structural electrical members.

Float Bodies of "Kel-F" and powdered metal incorporated in flowmeter bodies machined of "Kel-F" for smaller, more accurate measuring devices for severe corrosives, liquid or gaseous.

Welding, by "hot gas" method being used in fabrication of corrosion-resistant feed hoppers.

Visit the Kel-F **POLYMER EXHIBIT** *at the Basic Materials Show May 17-20--Chicago, Ill.*

For complete information regarding any item mentioned in DESIGN AND PRODUCTION NEWS, ask for detailed APPLICATION REPORTS, write

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P. O. Box 469, Jersey City 3, N. J.
or offices in Boston, Chicago, Dayton, Los Angeles and New York

KELLOGG PULLMAN

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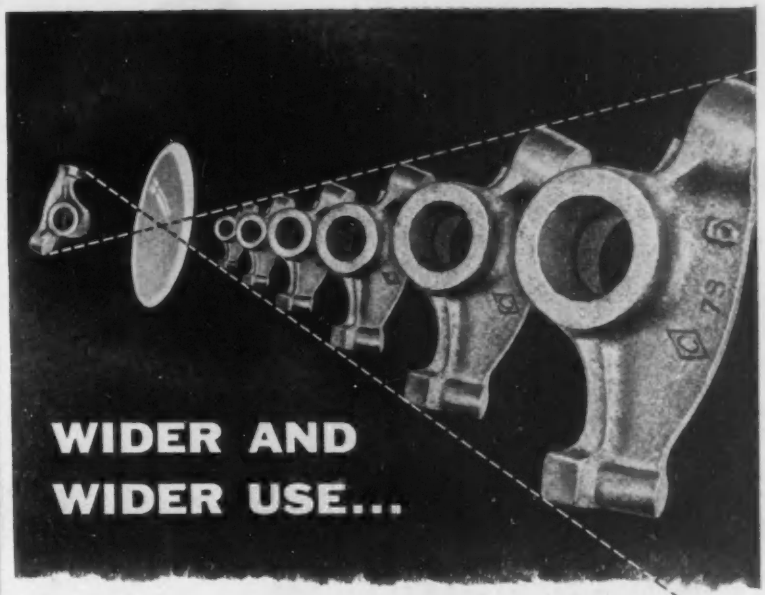
Ad Libbing by the Editor

Too often one hears about "poor" properties of materials and "good" properties of materials. Usually the adjectives are used incorrectly; there are no such things as "good" properties and "bad" properties of materials. The properties may be "good" or "bad" for a given application but in themselves the properties are neither good or bad. It reminds me very much of a definition of a weed.

No matter what the plant may be, in itself it cannot be classified as a weed. A plant only becomes a weed when it becomes a hindrance to the farmer or horticulturist. The common dandelion is considered a weed when it infests a lawn. But if the dandelion is grown for the market it is no longer a weed. Morning-glories are considered beautiful when they adorn a lattice on a cottage in the east. But in many of the western states the morning-glory is a cursed weed that is a terrific hindrance to the farmer.

The graphitic structure of cast iron may be considered "bad" because it lowers the strength of the material. On the other hand it is extremely desirable if the material is to be used where it is desired to deaden vibrations. Iron is often spoken of as a brittle material, which it is relative to ductile iron, but this is not necessarily a "bad" property. It is an extremely "good" property if we are using the material for a shear pin.

Thus we see that "good" and "bad" may be meaningless words when used in connection with engineering design problems and considerations. After all, the only thing that the design engineer is interested in is the end result and the degree to which the construction satisfies the service requirements. If brittleness is required, a brittle material is a "good" material while a ductile material is a poor material for the application. On the other hand, if minimum inertia is required, a material of low density will be desired. But if maximum inertia is desired in a



PEARLITIC MALLEABLE CASTINGS as engineers see its many advantages

DESIGN ADAPTABILITY: Because of its good fluidity, it can be cast in thin sections and in complicated shapes.

HIGHER STRENGTH: Ultimate strengths range between 60,000 and 90,000 psi; yield strength between 40,000 and 70,000 psi.

EASILY MACHINED: Machinability index (B1112 Steel = 100) ranges between 80 and 90.

WEAR RESISTANCE: Withstands excessive wear under heavy loads at high speeds.

LOCALIZED HARDENING: Sections of the casting can be flame hardened or induction hardened before or after machining.

BEARING PROPERTIES: Good non-seizing properties in metal-to-metal contact.

FINE FINISH: Can be given a very smooth finish where desired.

You will find many applications for Pearlitic Malleable castings – particularly as a replacement for forgings, stampings and weldments – where reduced weight, less machining time, fewer assembly operations and better appearance are important production and sales considerations.

A-9277

NATIONAL MALLEABLE AND STEEL CASTINGS

COMPANY
Cleveland 6, Ohio

The Nation's largest independent producer of malleable and pearlitic malleable

✓SAVE UP TO 40% SPACE!

✓EXTRA HIGH SAFETY FACTOR!

✓DEPENDABILITY . . . backed by 38 Years of Know-How!

CIRCULAR HEADS WITH TIE RODS
SQUARE HEADS WITH TIE RODS
T-J
T-J
T-J
SPACE SAVED
T-J SPACEMAKER . . . provides additional room for adjacent equipment without sacrificing strength.

Off shelf delivery all styles to 3" bore in increments of 1" to 12" stroke.

NEW T-J

Spacemaker

AIR CYLINDERS

Streamlined design of the new T-J Spacemaker *eliminates tie rods . . . saves up to 40% in mounting space!* It's performance-proved . . . *super rugged* with extra high safety factor . . . solid steel heads . . . heavy wall, precision honed, *hard chrome plated,* seamless steel body . . . leakproof cylinder head to body construction . . . heavy duty, hi-tensile, *hard chrome plated* piston rod.

Available with the new T-J Super Cushion Flexible Seals which insure positive cushion with automatic valve action for fast return stroke. Many standard sizes and styles . . . for pushing, pulling, lifting, clamping or control jobs. T-J dependability. Write for bulletin 454. The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON

RIVETORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS

rotating wheel, high density material will be "good" material to use while low density material will be undesirable.

We can carry this logic one step further into human relations and qualifications for jobs. Too often certain characteristics and attributes are lauded while their opposites are deplored. We often praise loudly the extrovert for his ability to "sell himself". And if selling is the job, the introvert would be a dismal failure. On the other hand, the extrovert would be a terrible flop on any job requiring philosophical reasoning or deep analysis.

The languid easy going good natured individual may be supreme in a job requiring meticulous care and exactness. On the other extreme, the high strung individual may be the better qualified for handling problems requiring quick decision and immediate action.

Old Fred Brown was a wonderful master mechanic. Slow in motion and slow but sure in thinking, he had the answers to all the problems that came his way. The only records that he kept were the facts that he memorized. As long as his company was producing the same products and materials and the plant remained practically static in size and layout, old Fred was extremely efficient and highly satisfactory in his job. Then came a time when the plant was expanded, new products were brought in and the job became bigger in all directions. The very characteristics that made Fred so extremely valuable before, now became a great handicap.

There were too many things to be able to carry them all in his head and he knew not how to keep records. Decisions had to be made quickly but Fred always wanted to "mull things over". Expanded production required higher speeds both physically and mentally. It was no longer helpful to know how a job had been done 20 years ago because the jobs were all new. Although not yet an "old" man, Fred had to be relegated to a "consulting capacity", at which he was excellent, and the job of master mechanic was turned over to a younger man.

Some people might feel that it was cruel to take away Fred's job as master mechanic. In fact, it was the finest thing that happened to Fred in spite of the fact that at the time it was done he felt terribly hurt and humiliated.

PHOTO COURTESY JOHN BEAN DIVISION, FOOD MACHINERY CORPORATION, LANSING, MICHIGAN

one-man orchard sprayer covers up to 80 acres a day with **CHRYSLER** *high-speed power*

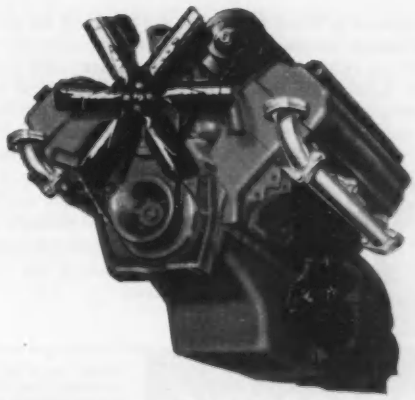
Here's a kind of mist that *saves* the American grower thousands of dollars in fruit every year. It's a driving mist composed of an insect and disease killing solution so finely atomized that for a few moments it actually replaces the air surrounding the trees. In that way it penetrates everywhere, leaving every leaf, twig and growth with a protective covering.

This grower is using a heavy-duty John Bean Speed Sprayer with 500-gallon tank capacity. Its 40-inch fan delivers 60,000 cubic feet per minute of low-velocity air, and this in turn sends the spray out as a driving mist. Result: A more thorough spraying job completed in less time, with less spray material.

The Speed Sprayer uses the Model 19 Chrysler Industrial V-8 Engine. Its 276 cubic inches displacement drives the agitator which constantly mixes the spray material, the centrifugal pump which forces the solution into the air stream, and the blower fan which sends it out as mist.

Chrysler offers its industrial engines equipped to meet the needs in the field. The engines for Speed Sprayers, for example, operate with gasoline-burning carburetors and are equipped with large, heavy-duty air cleaners and corrosion-resistant electrical systems.

Why not see the nearest Chrysler Industrial Engine Dealer for complete information on engines for your equipment. Despite all their advantages, Chrysler Industrial Engines are not expensive. Production-line methods adapted to specialized industrial engine building provide a custom-built engine at mass-production prices. If you prefer, write: ***Dept. 55, Industrial Engine Division, Chrysler Corporation, Trenton, Michigan.***



CHRYSLER ***Industrial Engines***

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Forgings

Engineering, production and economic advantages obtainable with closed die forgings are presented in this Reference Book on Forgings. Write for a copy.

combining strength with unmatched toughness, are indispensable to the operation of all types of aircraft

. . . especially those types that are used for the defense of our country. A product fortified with the metal quality found in forgings outperforms other products. Forgings are used for the toughest work loads. Check all the parts, particularly those which are subject to greatest stress, that make up your product. Check these parts with the aid of Problem Parts Attack Charts which are available upon request. These charts reveal the unrivaled economic and mechanical advantages of closed die forgings and relate them to specific engineering and production problems. Then consult a Forging Engineer about the correct combination of mechanical properties which closed die forgings can provide for your product.

DROP FORGING ASSOCIATION

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Please send 64-page booklet entitled "Metal Quality—How Hot Working Improves Properties of Metal", 1953 Edition.

Name .....

Position .....

Company .....

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In the end, Fred was happier and everybody else, including his associates, were better off.

It often requires considerable courage to be "cruel". Many a young man when promoted to a position of authority becomes very fearful about the way he treates his subordinates and becomes extremely careful in his attitude towards his associates. Afraid to hurt the feelings of the men under him he tempers his commands and criticisms to the point where they become supplications and mild suggestions. To avoid the possibility of his associates disliking him he becomes studiedly courteous, unremonstrative and almost rabid in his desire to please. He even carries the same attitude in his relations with his superiors and he treats them with a deference bordering on reverence. He is always quick to agree.

Ironically, such an attitude breeds disrespect from the subordinates, even to the point of despising him. On the other hand, one of the hardest bosses I ever worked for was admired and highly respected by almost all of the men under him. Of course there will always be a few who hate a demanding boss. That may prove that the boss is a good one.

Mr. Fred Gutmann of Caldwell, New Jersey was another one who took the trouble to write into me calling attention to the error in "Sans, Souci" in the January number regarding Frederick the Great. Mr. Gutmann presented the case so concisely and precisely that I will quote him exactly:

"Re Sans, Souci in the January issue: Frederick the Great was King of Prussia and Elector of Bradenburg. The Holy Roman Empire was still flourishing, with Maria Theresia of Habsburg at its head—in Vienna. And Frederick fought the Seven Years War Against Maria Theresia. There was no German Empire until 1871 when Bismarck made the King of Prussia the German Emperor."

Nothing is as unpredictable as human behavior. If humans weren't intelligent it would be possible to foretell exactly how a person would react to every situation, just like we can tell what a dumb chicken will do. Hence, humans are so smart it is impossible to predict their behavior but they are not smart enough to realize it. But if humans were dumb enough to be predictable they would be too dumb to be able to predict. —G.F.N.

It's welded... but you can't feel the weld

• A special tool removes any exterior weld flash from electric-welded steel tubing immediately after welding . . . thus the *eye-appeal* of products like tubular steel furniture. If required, the inside can be similarly finished, meeting the *functional* requirements of products like pneumatic tube systems.

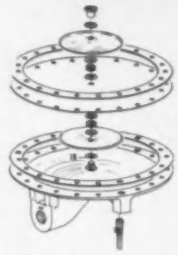
Investigate the economy and physical advantages of Brainard welded steel tubing for *your* products. Write Brainard Steel Division, Dept. GG-5, Griswold Street, Warren, Ohio. An integrated producer; offices throughout the U. S.

Brainard
SHARONSTEEL
STEEL DIVISION
SHARON STEEL CORPORATION

WELDED STEEL TUBING

Tail section of a Douglas C-124, showing maze of heating and ventilating ducts

Aerotec pressure switches control heaters for thermal de-icing of flight surfaces
as well as personnel heaters supplying the immense cabin and cockpit



Heart of this instrument is a diaphragm and two gaskets of COHRLASTIC 3010, the only material available that can withstand extreme heat and cold and thus activate the switch when the water manometer changes six millimeters. Despite this extreme sensitivity, these switches carry an electrical load of 10 amps at 28 vdc.

Just a dormant idea . . .
until along came COHRLASTIC 3010

Today this super-sensitive switch is used by every major aircraft manufacturer

This turtleback shell houses a delicate mechanism that must operate unfailingly under the hazards of elevated engine heats and sub-zero temperatures of stratosphere flying.

Mr. John V. Oliveau, vp Engineering, Aircraft Division, The Aerotec Corporation, writes: *"The high degree of dependability achieved by our switches in production over the past five years is, to an important extent, attributable to the remarkable properties of your Cohrlastic silicone rubber coated fabrics. We guarantee several types of this basic model to perform their function at all temperatures between −65 and +360 F., which is well within your operating limits of −100 and +500 F".*

SWATCHES AND LITERATURE ON REQUEST

COHRLASTIC

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PRODUCT OF THE Connecticut HARD RUBBER COMPANY

MANUFACTURERS OF SILICONE RUBBER COATED FABRICS REINFORCED WITH FIBERGLAS, NYLON, DACRON AND ORLON FOR SPECIFIC APPLICATIONS. MOLDED SHEETS, CUSTOM PARTS, EXTRUSIONS, PRESSURE-SENSITIVE TAPES, HIGH TEMPERATURE DE-ICING SYSTEMS, NON-LINEAR MOUNTS, CONDUCTIVE GASKETS.

ENGINEERING ABSTRACTS

Avoiding Overheating When Starting Electric Motors

Abstracted from "Avoiding Overheating in the Starting of Electric Motors," *Mechanical World*, March 1954.

THE TEMPERATURE RISE of a motor is the factor which determines the rated full load of the motor. When an a-c motor is running there are various losses in the machine which cause heat to be generated. There are resistance losses, equal to I^2R watts, or I^2R joules per sec, and iron losses in the cores through which the alternating flux passes, these comprising eddy currents and hysteresis.

On a given a-c supply, the iron and frictional losses are practically independent of the load, but these losses increase as supply frequency and flux density go up. In consequence, the iron losses are greater when a motor is used on a supply of increased voltage because the magnetic flux density rises.

In a squirrel-cage motor which is started by direct-on-line switching, the initial starting current may be many times greater than the full load current. Thus, the rate of heat generation in the conductors during starting may be much greater than the heating on full load.

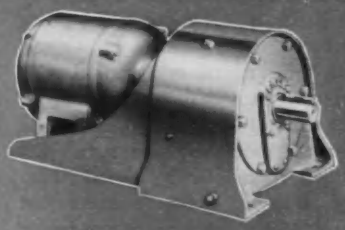
The initial temperature rise of a cold motor is usually negligible, the generated heat being largely absorbed by the cores and frame of the motor. Rate of temperature rise is equal to the quantity of heat produced per second, due to motor losses, divided by the thermal capacity of the motor. However, the windings of the motor may have a high temperature in spite of the comparatively cool case, especially if the insulation has a low thermal conductivity.

The initial current taken by a motor when switched on to the supply with the rotor at rest depends on the design of the motor and the starting voltage, and is independent of the load against which the motor has to start. The duration of the high-current starting period is inversely proportional to the accelerating torque, which is equal to

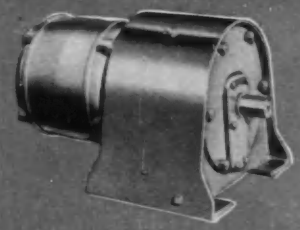
many types, sizes, styles, arrangements...

ALL-STEEL FALK Motoreducers

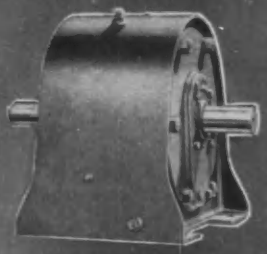
cover the entire application range



Type EZ, All-Motor Horizontal Motoreducer. Accommodates any make or type of foot-mounted motor.



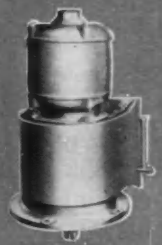
Type EF, Integral Horizontal Motoreducer. Standard NEMA D-flange motor mounts directly on Motoreducer housing.



Type EC, Concentric Shaft Speed Reducer. Coupling, chain or belt driven.

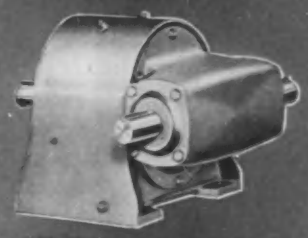
Type EBZ, All-Motor Right Angle Motoreducer. Any output shaft position (see below, right).

Type EBF, Integral Right Angle Motoreducer. Employs NEMA D-flange motor.



Type EFX, Integral Vertical Motoreducer. Employs NEMA D-flange motor.

Type EZX, All-Motor Concentric Motoreducer. For vertical applications.



Type ECB, Right Angle Speed Reducer. Any output shaft position; coupling, chain or belt driven.

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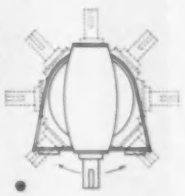

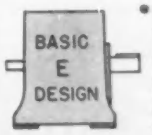

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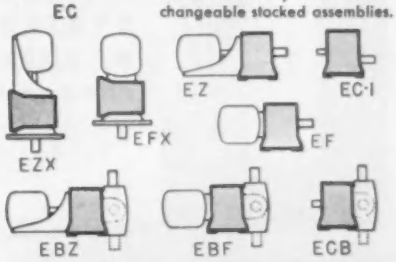

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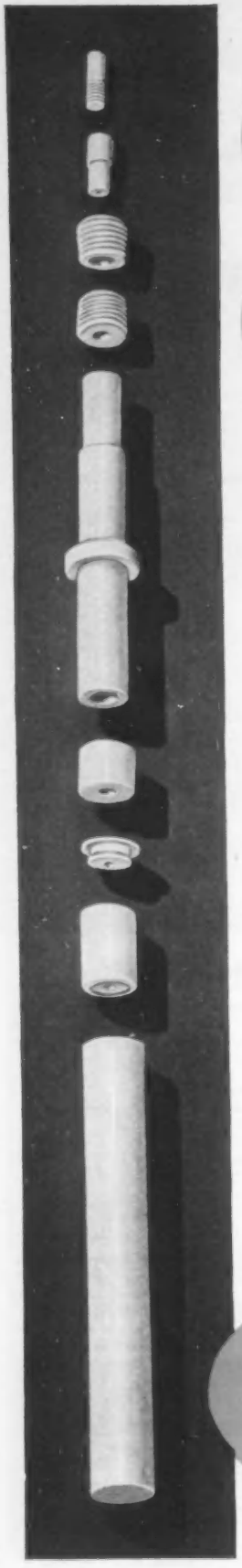

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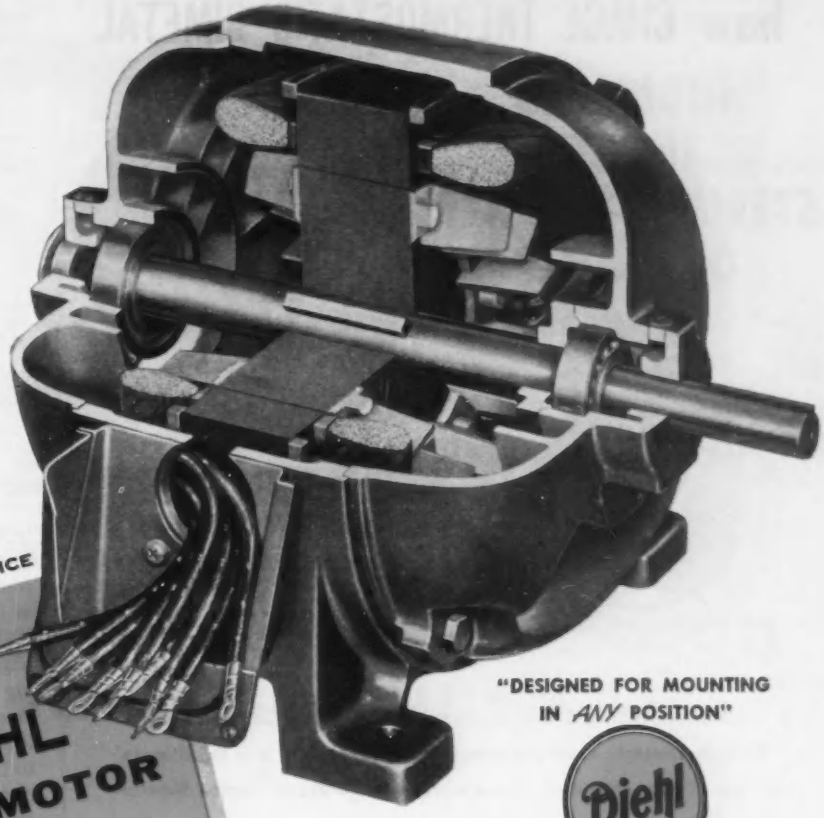
the amount by which the motor torque exceeds the load resistance torque, and is proportional to the inertia of the rotor and the moving parts of the load.

The type of motor and starter should be such that the starting period for a squirrel-cage motor with a direct-on-line starter, or a star-delta starter, does not exceed (15 + rated hp/4) seconds, these figures being based on a starting current of not more than six times the full load current. Short-time rated resistances in resistor starters may overheat if the starting period is unduly prolonged or the motor started too frequently. Consequently ordinary-duty resistor starters, such as faceplate starters, are suitable where the motor has to be started once or twice an hour. If a motor up to 10 hp can accelerate to full speed in 10 sec, the accelerating time of a motor of 10 to 50 hp does not exceed (5 + hp/2) sec. or that of a 50 to 500 hp motor does not exceed (25 + hp/10) seconds.

An intermittent-duty resistor starter can be used for up to 15 starts per hour if no sequence of starts exceeds one minute and the initial starting current does not exceed 200 percent of full load current in the case of a motor up to 25 hp, 150 percent for motors of 25 to 100 hp, or (100 + 5,000/hp) percent in the case of motors over 100 horsepower.

Frequent-duty resistor starters, which can be of solenoid or contactor type, can be used for up to 40 starts per hour if no sequence of starts exceeds two minutes. This condition holds if the initial starting current of a three-phase induction motor up to 25 hp is not more than 250 percent of full load current, that of a 25 to 100 hp motor is not more than 225 percent, or the starting current of a motor over 100 hp is not more than (125 + 10,000/hp) percent.

The transformer in an auto- transformer starter is usually short-time rated and also is apt to overheat if the starting period is unduly prolonged, the starting current is excessive, or the motor is allowed to remain stalled with the starter in the "start" position. The short-circuit current of the motor is the initial current taken when the motor is switched direct on to full supply voltage. If this short-circuit current does not exceed six times the full load current, an ordinary-duty auto-transformer starter such as a hand-



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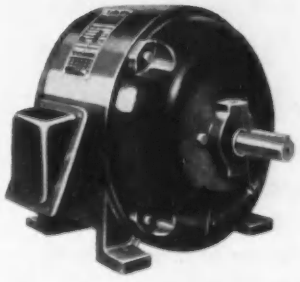

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When oil pressure increases, pressure on contacts increases and opening is delayed. Current thus flows for longer periods during the cycling, more heat is generated in the gauge bimetal elements and pointer is forced to higher reading. While the current fluctuates, lag in heating and bending of bimetal arrests vibration of pointer. Actually the sending unit meters out current consistent with oil pressure and the gauge records it. Many manufacturers throughout the world who make products which are actuated by bimetal response to temperature changes, specify Chace Thermostatic Bimetal. Chace assures large and small users of a reliable source of supply of bimetal to meet a wide variety of specifications.

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operated starter, is suitable for up to two starts per hour if the starting period is not more than 15 sec for motors up to 20 hp, (5 + hp/2) sec for motors of 20 to 50 hp, or (25 + hp/10) sec for larger motors. An intermittent-duty auto-transformer starter, which may be of the contactor type, is suitable for up to five starts per hour if no sequence of starts exceeds one minute. A frequent-duty auto-transformer starter, which may be of the contactor type, is suitable for up to 40 starts per hour with no sequence of starts exceeding two minutes.

It is, therefore, essential that a motor accelerate its load in a reasonably short time. A motor may fail to start or to accelerate rapidly if the strating torque of the motor is too low, the resistance torque of the load too great, or the load has a high inertia. Thus, if the motor fails to start properly the remedy for overheating during starting may be to reduce the starting load, possibly by incorporating fast-and-loose pulleys or a clutch in the drive to enable the motor to start unloaded; or to increase the starting torque available.

The starting torque of an induction motor is almost proportional to the square of the voltage applied to the stator elements. The voltage may be low because of low supply voltage or undersized conductors. The voltage in one phase may be low due to high resistance at some point, or to unbalanced single-phase loads on the polyphase system.

The design of an a-c motor governs the ratio (starting torque/full load torque) on a given voltage, hence faulty starting may be remedied by using a different type of motor. For instance, a normal squirrel-cage motor usually has a greater starting torque than a squirrel-cage motor with a high-reactance rotor, while a high-torque double-cage motor or a motor with a high-resistance rotor has a greater starting torque than a normal squirrel-cage motor. The latter two types of motor and a slip-ring motor have a lower ratio of starting current to full load current than a standard squirrel-cage motor, thus producing appreciably less heating during starting.

Many single-phase split-phase and capacitor motors have a low starting torque, a greater starting torque being provided by capacitor-start and capacitor-start-and-run motors, although the

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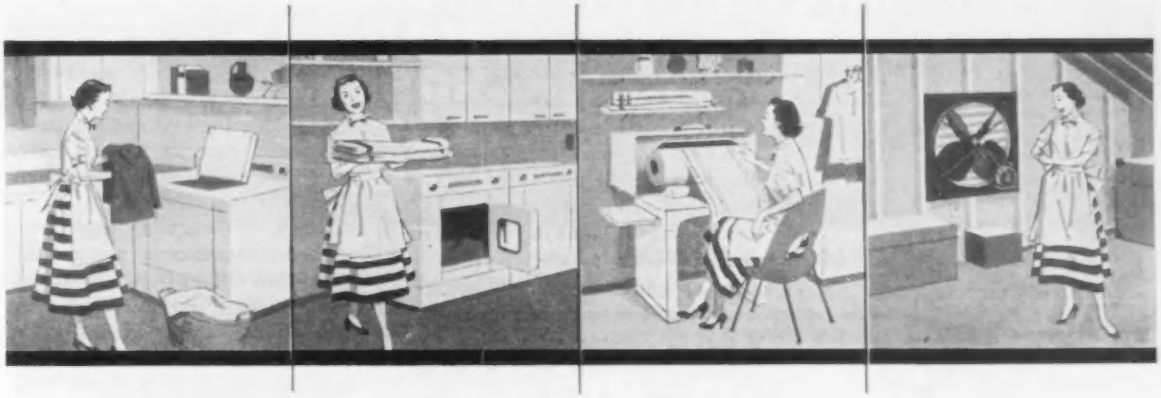

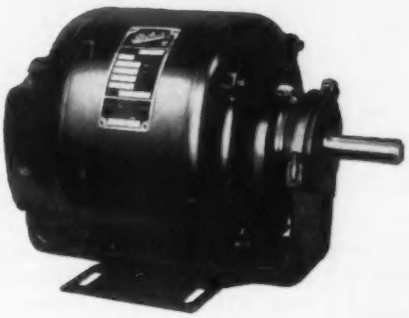

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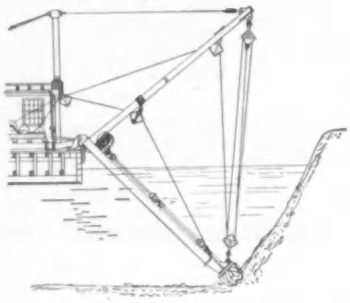

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actual starting torque will depend on the design of the motor. Rapid starting is essential to avoid overheating of resistors and short-time rated starting windings used with many such motors. Single-phase split-phase starting motors, capacitor-start motors, and capacitor-start-and-run motors usually incorporate a centrifugal switch which switches off the starting windings, or alters the connections to the starting windings, when the motor has accelerated to a predetermined speed. This switch should close when the motor is switched off, so that the connections are correct for restarting.

A repulsion-start-induction motor has a centrifugal device which short circuits the commutator when the motor has accelerated to a certain speed at starting. Often the device is arranged to lift the brushes from the commutator.

Polyester Stress Corrosion

Abstracted from "The Crazing of Polystyrene" by E. E. Ziegler, Dow Chemical Co., *SPE Journal*, April 1954.

A MORE THOROUGH KNOWLEDGE of crazing in polystyrene is an important step in designing and molding better parts, testing them for internal quality once they are molded, and developing new plastic materials.

Crazing is thought to result from localized elongations of greater magnitude than the material can accept. "Stress crazing," is associated with stresses contained in or exerted on the plastic molding, including: (1) orientation stresses caused by forced molecular alignment or disturbance during the molding operation. (2) Packing stresses caused by forced injection of additional polymer during thermal contraction of plastic material cooling in the mold. (3) Thermally induced stresses caused by differential cooling of the plastic during the molding process. (4) Stresses caused by thermal shock on the entire molding, or by localized overheating of certain areas during machining and finishing operations. (5) Mechanical stresses resulting from externally applied load.

"Solvent crazing" is associated with the lowering of critical elongation by chemical action of a wide variety of reagents. One of many references to this in the literature explains this phe-

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★ *Calidyne's primary interest is to develop a complete line of vibration test and measurement equipment. Of this line Calidyne's custom-built Shakers are now the best known. They are produced in many sizes to meet individual requirements and are used for shake-testing (vibrating) various objects (assemblies, machines, vacuum tubes, etc.) to see what effect vibration will have on them in actual service. Many product manufacturers now find that they fill a very basic need. Perhaps you should investigate them too?*

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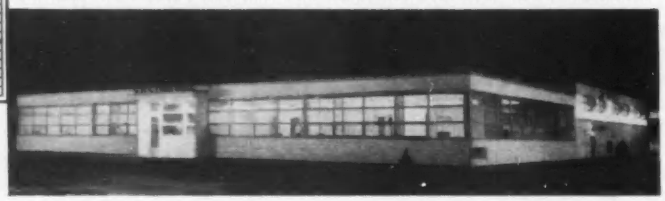

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nomenon as a plasticizer action which reduces the attractive forces between polymer chains so that they may pull apart at the lower strain. It is also common for crazing to result from a combination of chemical action and mechanical stress.

It is generally agreed that crazing is the beginning of failure in plastic moldings, an unavoidable conclusion when it is realized that crazing is composed of small but definite cracks or openings within the plastic material. When a crack appears, it naturally reduces the area over which the remaining load must be distributed.

The rate of penetration of crazing in polystyrene has been determined over a range of stresses. In summary, for a given stress, craze penetration increases linearly with time, and for constant time, it increases with stress. In the case of constant load application this means that, as the number and size of craze cracks increase, the unit stress becomes progressively greater on the unruptured area. Therefore, it is obviously of utmost importance in constant load applications to prevent crazing from starting, since the inevitable result of even minor crazing under these conditions is eventual mechanical fracture of the molding.

Fig. 1 indicates that the loss of critical elongation from its "zero" time value to the minimum equilibrium value attained after 50 hr amounts to approximately 60 percent. This correlates well with previous work done on long time tensile loading of injection molded polystyrene where it was learned that test bars would hold only about 40 percent of their rated ultimate tensile strength in long time constant load tests.

This is an important point for the designer. It emphasizes the need for a large safety factor in the design of polystyrene moldings involved in tensile loadings. It also indicates the need for more complete, actually more

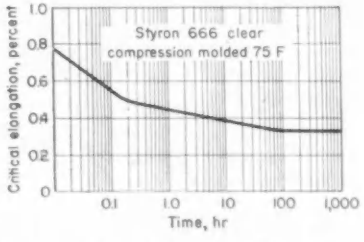


Fig. 1—Effect of time on crazing.

realistic, values of tensile strength in plastics property determinations.

Actually, a polystyrene molding cannot withstand the quoted ultimate tensile stress of 6,500 psi for more than a few seconds without breaking. From the critical elongation values just quoted, it can be seen that unoriented polystyrene can withstand no more than 0.32 percent elongation, or approximately 1,500 psi, for an indefinite period without breaking. As will be brought out clearly a little later, it will not even hold this load if the exposure temperature is raised above 75 F or if reagents other than air or water are brought into contact with it.

The conclusions drawn for constant load do not necessarily apply to applications involving constant strain. In the latter case the deflection or elongation is held constant: the load is not. The occurrence of a few craze cracks under such conditions may well mean that the "weak links" in the molding have been broken, that the remaining stronger portion can accept the elongation involved, and that, by virtue of some creep or cold flow, the actual stress becomes progressively lower and the molding maintains its visual appearance and mechanical strength without further change as long as the loading conditions remain unaltered.

The important effect of orientation on crazing and tensile strength is further emphasized by the fact that these domains can carry considerable stress in their longitudinal direction but only very little stress in the transverse direction. Thus when tensile stress is applied in the direction of orientation to specimens previously oriented to 1,000 percent, for example, crazing is not observed because there are no domains left oriented at right angles to the tensile stress and the fracture, when it occurs, if of a fibrous type.

The variation of polystyrene's critical elongation in air or water over a

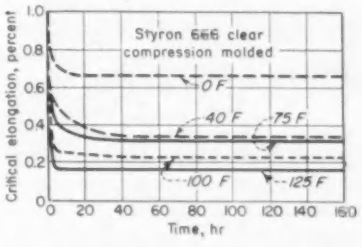
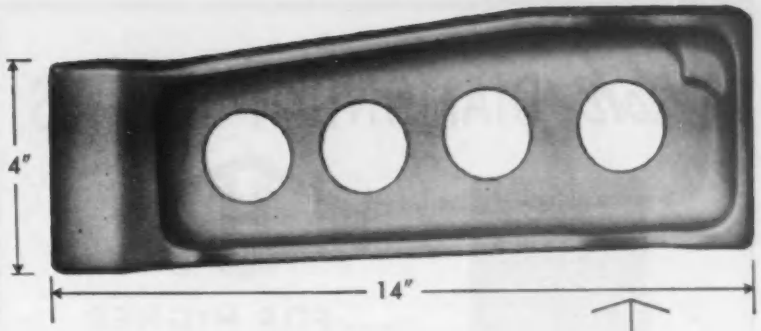


Fig. 2—Effect of temperature on crazing.



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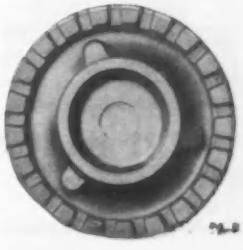

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In their field still the smallest and lightest, (1.6 cu. in., 3.76 oz.) combining highest operating shock resistance (to 50 "G" and higher), widest temperature range (−65° to +200° C.) and greatest ability to break high currents and high voltages, Series R Relays consistently operate over 400,000 cycles without failure at 5 A. and go 3,500 or more under 30 A. at 30 V., D.C., resistive. They carry voltages up to 300 D.C. at 4/10 A. for more than 400,000 cycles. With low contact loading, life expectancy is 10 million cycles or better.

Operating time is 10 ms. or less; drop out time 3 ms. or less. Coil resistances up to 35,000 ohms are standard; to 50,000 ohms available for special units. Sensitivity approaches 100 mw. at 30 "G" operational shock resistance. Inter-electrode capacitance is less than 5 mmf. contacts to case—less than 2½mmf. between contacts, even with plug-in type relay and socket.

Designed to meet all requirements of USAF Spec. MIL-R-5757B, they far surpass many. Bulletin R-150, giving basic performance data under varying conditions, is yours on request. Our engineers are prepared to work with you to develop variations to meet your specific requirements. Tell us your needs.

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wide temperature range is shown in Fig. 2. Above 32 F, the time required to reach minimum equilibrium elongation is inversely proportional to the temperature. It is expected that the critical elongation would continue to drop with increase of temperature until the ultimate elongation of the material would rise as it softens near its heat distortion point. Above this temperature, critical elongation has no practical significance.

Noise in Composition Resistors

Abstracted from "Measuring Noise in Resistors," by Milton E. Koch, Jr., *Electronics*, March 1954.

VARIOUS METHODS have been used to measure total noise in resistors, to give information about existing resistors, and to provide a research tool for development of quieter resistors. The simplest noise-measuring method is to insert the resistor in a high-gain amplifier and measure its output, comparing one resistor with another.

The noise-measuring equipment used for these tests has an extended low-frequency response with sufficient gain and stability for very low-level measurements. The total noise (in microvolts) and the relative noise (in db above that of a standard resistor) can be read directly.

Direct-current voltage is applied to the test resistor through a series matching resistor, and the noise-signal voltage is coupled through a capacitor to the amplifier circuit. The series resistor is matched as closely as practical to the value of the test resistor. Since noise in this series resistor would also be amplified, wire-wound resistors are used.

The equivalent circuit of a noisy resistor is a resistance of the same value in series with a noise generator whose output magnitude is a function of the direct current through it. In the testing circuit, the calibration voltage is inserted in series with the test resistor eliminating the calculations necessary with other methods of testing.

Test Results

Using this equipment, an investigation was made into the behavior of conventional composition resistors carrying small d-c currents. In a typical 1.0 megohm, ½ watt resistor, noise

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increased approximately linearly as the d-c voltage across it was varied from zero to ten volts. The noise output at zero d-c volts was the same for all one-megohm samples, but with d-c voltages applied the rate of increase varied with the particular sample. Parts of the increase in noise can be attributed to the rise in temperature of the resistance material, and the corresponding rise in thermal noise. However, since thermal noise is proportional to the square root of the Kelvin temperature, a change from room temperature to the boiling point of water would only increase the noise level about 13 percent. The noise level of the quietest of composition resistors makes this change negligible. A ½ watt, one-megohm resistor with ten volts d-c applied, is dissipating only 100 microwatts but might be generating five or ten times the thermal noise at room temperature.

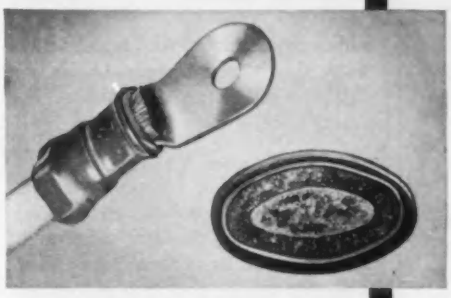
Noise Causes

The chief cause of the increased noise is probably due to a fluctuating resistance effect. If a non-homogeneous resistance material is considered as being made up of a large number of small resistors in a complex series and parallel arrangement, the total current through this configuration divides up into many separate routes. The exact path of each minute current can vary as the small resistances are cut in and out of the circuit by local action, so the net effect is continual small changes of the total resistance of the resistor. These fluctuations in resistance cause fluctuations in the voltage across the resistor and hence appear at the output as noise.

The nature of this secondary, or fluctuation, noise differs from that of thermal agitation alone. The thermal-noise energy is spread out evenly over the entire spectrum.

Expansion of Frequency Range

Extending low frequency range of a high-fidelity audio amplifier has little effect on the noise output. The fluctuation noise, however, has most of its energy in the lower audio range. The exact spectral distribution varies considerably for different samples, but in general the greatest portion of the total noise energy is below 200 cycles and extending the low-frequency response results in greater noise output. When



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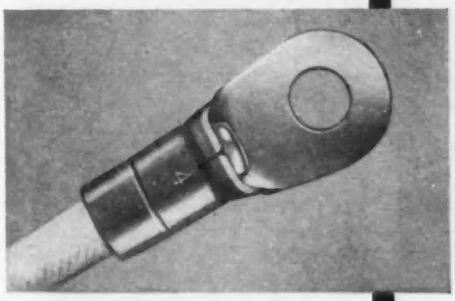

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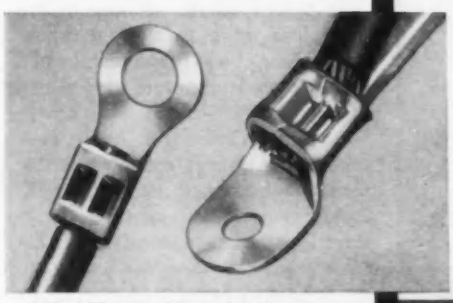
For applications where weight is the primary consideration, A-MP's novel cartridge type terminals, available in wire sizes 8 through 2, are applied with the same head as that used for AMPLI-BOND. These aluminum wire terminals offer, by way of insulation support, Confined "C" Crimp, and special inhibitor, a completely trouble-free termination.



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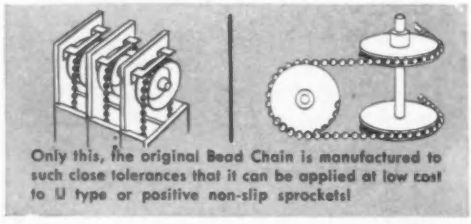

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sufficiently amplified with high fidelity, fluctuation noise and thermal noise can easily be differentiated by anyone listening to the equipment.

Higher Voltages

As higher values of d-c voltage are impressed on a composition resistor, the noise output does not increase so rapidly. Quiet resistors tested at their rated d-c voltage have less than three-microvolts noise per volt. A noisy resistor might have 100 microvolts per volt at low voltages, and 20 microvolts per volt at the rated voltage. The rated d-c voltage in all cases is that value calculated from the resistance and nominal power rating, up to the rated maximum operating voltage for the particular resistor type.

Composition resistors of identical type are made by many manufacturers, but the similarity disappears when noise is considered. Identical composition resistors from the same manufacturer showed about the same noise level except for a few wild samples which had much higher and more unstable noise levels than the others. This could be due to a local fault or to a poor end connection on the resistance element.

For reference purposes, a group of quiet composition resistors was selected, having values from 10,000 ohms to 5 megohms. Most of these had noise levels less than 0.5 microvolts per volt, but there was no obvious relationship between noise level and value of the resistance.

In regard to the stability of the noise level in a particular composition resistor, it was found that samples kept at room temperature for a period of one year showed no great change in noise when retested under the same conditions. Data is not available for samples subjected to normal d-c voltage for long periods of time, but in several instances resistors have become very noisy when functioning under pulse conditions.

Hydraulic Power Transmission

Abstracted from "Hydraulic Power Transmission," by J. R. Fawcett, *Power Transmission,* March 15, 1954.

ALTHOUGH THE CHOICE of a suitable system for many hydraulic power transmission applications is obvious, there are others where there are one

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The BASIC four-channel assembly includes: Cabinet, Recorder, and, for each channel, a BUILT-IN unit (A), which comprises a Driver Amplifier with frame, and a Power Supply with control panel.

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(B)

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Available plug-in Preamplifiers include: AC-DC, CARRIER, SERVO-MONITOR, DC COUPLING, LOG-AUDIO, and LOW LEVEL. Blank plug-in assemblies are also available for users to make input circuits for special measurement problems.

And, there are the popular Sanborn advantages: a high torque movement (200,000 dyne cms per cm deflection), direct *inkless* recording in *true rectangular coordinates*, and provision for code and time markings.

A new catalog on Sanborn Oscillographic Recording Systems and their components will be sent gladly on request.

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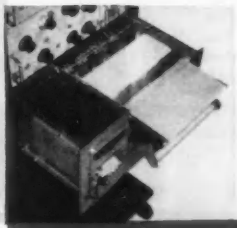
- Extended frequency response.
- Improved regulated power supply.
- Individual stylus temperature control for EACH channel.
- Improved, single control, paper speed selector. Nine speeds — 0.25 to 100 mm/sec.
- Recorder slides out, if desired, for better view of recorded events, or for notations on record (illustrated at right).
- Improved control of input signals by use of 1, 2, 5 ratios on attenuator.



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more or alternatives which require consideration.

Hydraulic power may be used either for applying considerable force, in which field it has no serious competition, or as a versatile, sensitive, infinitely variable and easily controllable means of transmitting powers of any magnitude from a few pounds or a fraction of a horse-power upwards. The power source is almost invariably a pump and the actuating elements are single and double-acting cylinders of many kinds and hydraulic motors.

The simplest system has a pump connected directly to the actuator through a valve and a supply tank. It is used on vehicles for operating tipping devices and implement lifts, for self-contained presses and for clamping devices on machine tools. The cylinder can be either single or double acting; the former being used if the return stroke can be done by gravity or spring pressure. This system has a wide application for small loads and has largely superseded the nut and screw, and rack and pinion for such purposes as vehicle tipping. As it is much easier to transmit power from the engine to the lifting mechanism hydraulically than it is mechanically, there is less to go wrong and little attention is needed. For large movements, the cylinder can be made telescopic and can be accommodated in a relatively small space.

By the addition of a gas-charged accumulator to this system—the hydraulic equivalent of an electric accumulator—it is possible to draw off power at will without the need to run the pump. With an accumulator it is possible, using a small pump, to have available for instant use a considerable amount of power; the pump need only be large enough to re-charge the accumulator before the next demand occurs. This system is used for operating diesel engine starters, hatch covers on ships, machine tools, presses, aircraft controls and wherever spasmodic demands for peak power are likely.

Many hydraulic applications require a rapid approach or return of the ram at lower power while the actual working portion of the stoke is carried out at high power. There are a number of ways of doing this, but for self-contained units the choice is usually between the fitting of an accumulator or the provision of two pumps (or a dual pump) having high capacity at the

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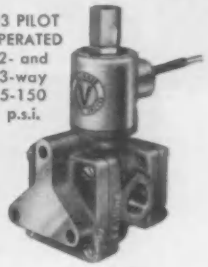
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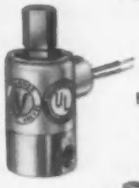
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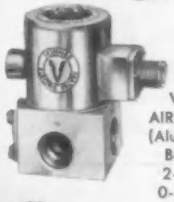
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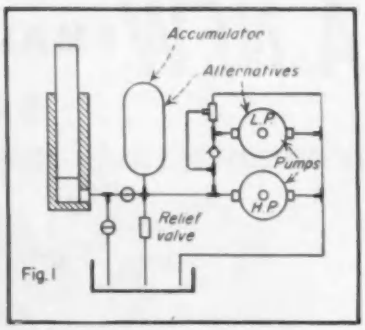

Fig. 1

working pressure, as in Fig. 1. At one time the pumps were arranged in parallel with both operating during the approach stroke, the low pressure being cut out automatically, as soon as the pressure reached about 200 psi. A more recent practice is to connect the high and low pressure pumps in tandem; the low pressure pump then primes the high pressure pump—a desirable feature with high-speed pumps—and as the capacity is deliberately made in excess of the high pressure pump, the output flows through the high pressure pump when the pressure is low. The only qualification is that the high pressure pump must have spring-loaded automatic valves which offer little resistance to the low-pressure oil flow.

Many hydraulic plants, particularly where batteries of presses are used, use a central pumping station which feeds the hydraulic mains. Unless the presses are designed with small kicker rams and a gravity fill for the main cylinder, it is wasteful of power to use high-pressure fluid to operate the presses on the approach stroke; means should be employed to make the approach stroke at as low a pressure as possible. A method frequently used is to provide two pressure sources—a high volume one at a low pressure (just sufficient to close the rams at a reasonable speed—ie., 300 psi) and a small volume high-pressure supply. The low-pressure supply can be conveniently supplied by a centrifugal pump, as this needs no special control equipment. The high-pressure system can be supplied by any convenient pump and it is usual to use an accumulator to stop the pressure dropping sharply when a valve is operated. The accumulator controls the high pressure pump.

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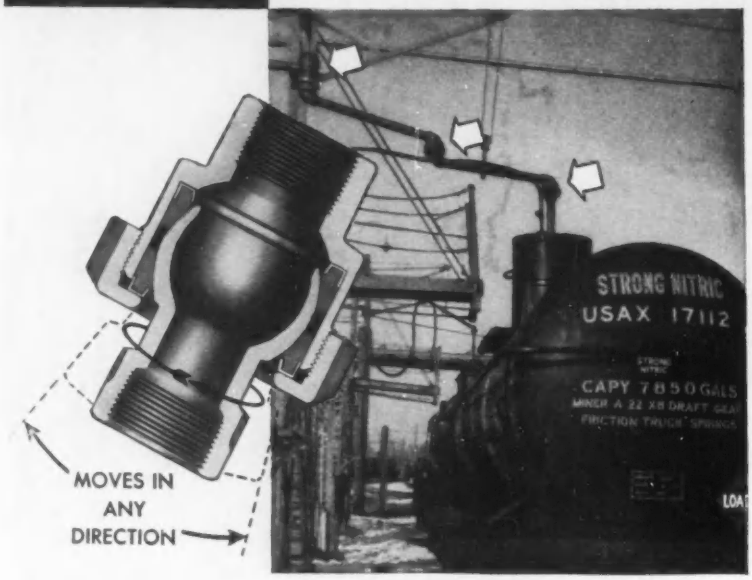

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NEW BOOKS

The Closeed Die Forging Process

P. E. KYLE, *Prof. of Metallurgy, Cornell University.* 5½ x 8½ *in.*, 142 *pp. Published by the MacMillan Co.*, 60 *Fifth Ave., New York* 11, *N. Y.* $1.50.

The purposes of this book are to describe briefly the essential steps in producing drop forgings and to discuss some of the uses to which closed die forgings can be adapted. The properties of forged metals are dealt with to some extent, and the fundamentals of hot working are explained.

The treatment is at such a level as to make the book useful to undergraduate engineering students. However, design engineers and users of forgings may perhaps use it to obtain a better understanding of the versatility of drop forgings.

One of the most interesting and perhaps most valuable sections of the book is the step-by-step pictorial development of the production of typical forged products.

Engineering Mechanics

FERDINAND L. SINGER, *Associate Professor of Engineering Mechanics, New York University.* 6 x 9 *in.*, 525 *pp. Published by Harper Brothers*, 49 *East* 33 *St., New York* 16, *N. Y.*, $6.

The new edition, the second, is completely rewritten and reset, retaining, however, the features which have been so well liked in the original edition—especially the "Theory Solution" technique and the rules of sign. Among the many new features of the text are the following: (1) a wider variety of problems, so that the instructor need not assign the same problem oftener than every four years. (There are approximately one thousand problems in the new edition, and practical applications are stressed). (2) Extensive discussion of how to draw free-body diagrams. (3) Fuller explanation and greater use of motion curves. (4) Extensive discussion of inertia-force method, and its use in simplifying the systems of connected bodies. (5) Simplified presentation of space forces. (6) Work-energy method applied di-

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rectly to connected systems. (7) Explanation of plane motion simplified. (8) The kinematics and kinetics of each type of motion now treated as a unit; hence kinematics principles are immediately applied to the kinetics of the motion.

As in the first edition, illustrative problems are solved in great detail. Answers to two-thirds of the problems are given, and a Solution Manual, giving detailed solutions for all problems, is available to instructors.

The Table of Contents is: Part I—Statics: Principles of Statics, Resultants of Force Systems, Equilibrium of Force Systems, Analysis of Structures, Friction, Force Systems in Space, Centroids and Centers of Gravity, and Moments of Inertia.

Part II—Dynamics: Principles of Dynamics, Rectilinear Translation, Curvilinear Translation, Rotation, Pane Motion, Work and Energy, Impulse and Momentum, Mechanical Vibrations, and Graphic Methods.

Elements of Mechanism

VENTON LEVY DOUGHTIE, *Professor of Mechanical Engineering, University of Texas,* WALTER H. JAMES, *Professor Emeritus of Mechanical Engineering, Massachusetts Institue of Technology.* 5½ x 8½ *in.,* 494 *pp. Published by John Wiley & Sons, Inc.,* 440 *Fourth Ave., New York* 16, *N. Y.,* $6.

Developing the valuable approach of the well-known Schwamb, Merrill, James and Doughtie work upon which it is based, this present book is an entirely rewritten version of Elements of Mechanism intended to inform the reader of new advances in the field by the use of up-to-date terminology and examples.

Like its predecessor volumes, the book is designed to fulfill two major purposes: (1) to acquaint the reader with the application of fundamental principles of physics and simple mathematics in the field of mechanical movement; and (2) to develop in the reader, through the study of the more fundamental machine elements and analyses of their motions combined in certain ways, the habits of thought and the powers of visualization necessary in the analysis of any mechanical device.

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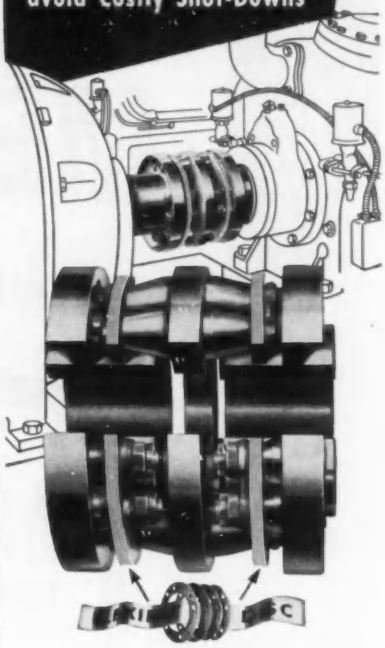

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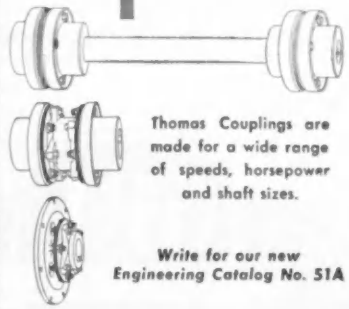

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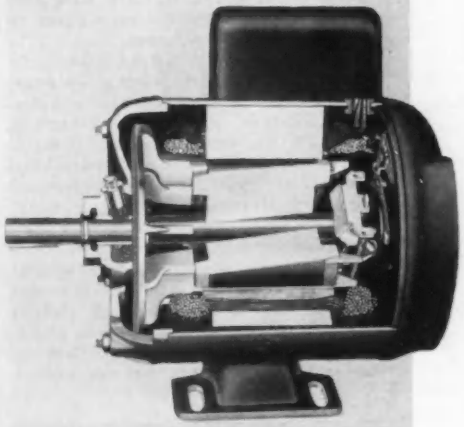

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material. Thus the book can be used to obtain a working knowledge of the entire subject or as a reference on slightly more advanced topics, such as the centro methods for obtaining velocities, Corioli's law, Klein's construction, and miscellaneous mechanisms. The number of problems included reduces the necessity of using an accompanying workbook.

The book employs the terminology of the various industrial fields and the examples used are of a type familiar in industry. Consistent symbols and notation are used throughout.

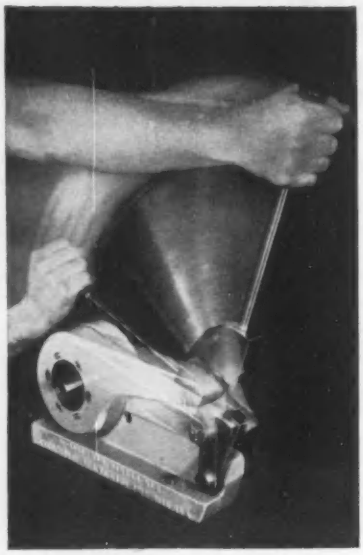
Materials and Processes

JAMES F. YOUNG, *Major Appliance Div., General Electric Co., Erie Pa. 6 x 9 in., 1,074 pp, John Wiley & Sons, Inc., 440 Fourth Ave., N. Y.* $8.50.

The emphasis in this revised edition has been placed on presenting a broad study of engineering materials and manufacturing processes from the viewpoint of the engineer. The subject matter has been organized to provide for textbook and reference use by students and practicing engineers, particularly those having product development, design, production, processing, quality and application responsibilities.

Other objectives sought in this revision are: (1) to expand the coverage of nonmetallic materials, constructional materials, and many materials and processes used in product industries; (2) to bring the presentation up to date with latest developments in physical metallurgy and chemistry, both in theory and in available materials; (3) to reorder the presentation to assist classroom use; and (4) to add typical material property data and process tolerances which should promote the book's usefulness as a "starting" reference and aid development in the student of the "sense of proportion" so necessary to engineering.

Most of the chapters have been completely rewritten to accomplish these objectives. New chapters have been added on Metallographic Examination; Structure and Properties of Nonmetallic Materials; Rubber; Ceramics, Porcelain and Glass; Miscellaneous Nonmetallic Materials; and Statistical Methods Useful in Quality Control. The old Heat-Treatment chapter has



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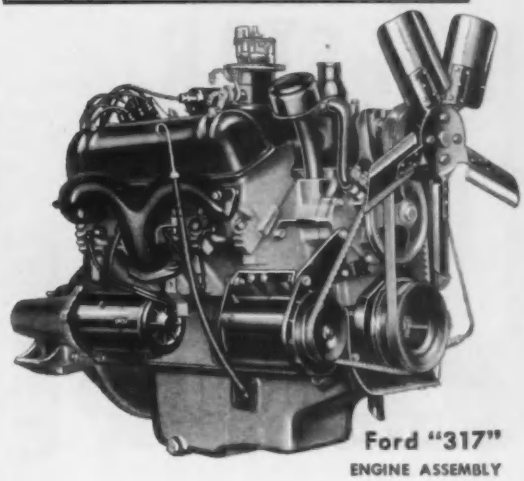

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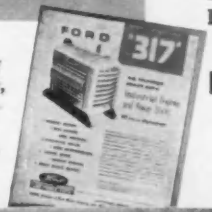

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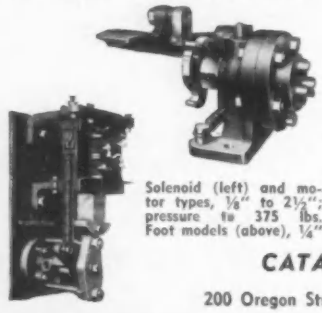

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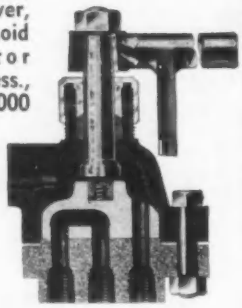

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been brought up to date and consolidated with chapters on Alloys, Iron and Steel, and Heat-Treating Processes to avoid duplication. Sections have been added on Tarnishing, Electric Contacts, and Nondestructive Testing, and the coverage has been expanded on many subjects, such as bearing metals, superalloys, nonferrous elements, blow molding, shell molding, and pressure welding.

In the study of metallic materials, properties are covered first and then specific materials available are reviewed in more detail, The nonmetallic materials are similarly covered. Bibliographies of many good works are listed with each chapter for those desiring more specialized subject treatment.

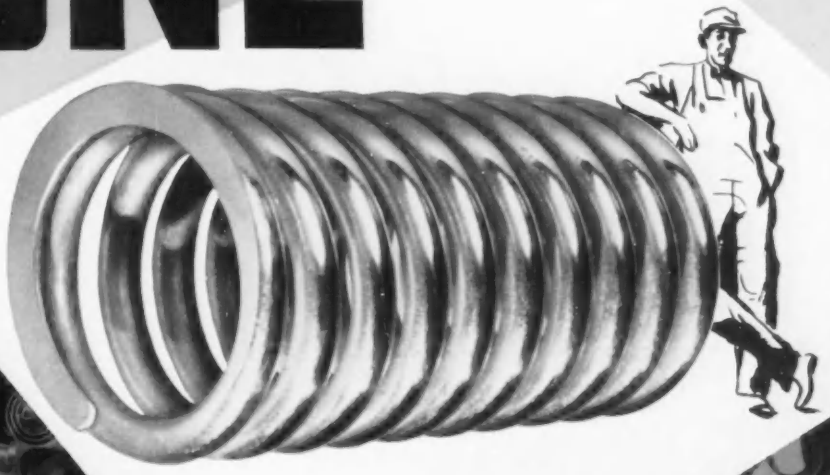
Mechanics of Materials

P. G. LAURSON, *Associate Professor Emeritus of Civil Engineering, School of Engineering of Yale University, and* W. JUNKIN COX, *formerly Commissioner of Highways, State of Connecticut. Formerly Asst. Professor of Engineering Mechanics, School of Engineering of Yale University.* 6 x 9 *in.*, 414 *pp. Published by John Wiley & Sons, Inc.*, 440 *Fourth Ave., New York* 16, *N. Y.*, $5.75.

The Third Edition retains much of the outlook of earlier editions. At the same time it has been largely rewritten in the interest of adding to the book's clarity and timeliness. The most important changes are the increased emphasis on the statics of stress determination, and the postponement of the material on stresses determined by deformation. The chapter on combined stress has been rearranged to give increased emphasis to Mohr's Circle. Other changes are: the revision of the tables of structural shapes which have been brought into conformity with present day standards; the inclusion of many new illustrations; and the addition of a whole series of new problems, many of them based on actual, well-known engineering structures.

The first fourteen chapters deal with principles and methods used in the design of ordinary structural and machine parts. Every effort has been made to present material in such form that students will have no unreasonable difficulty in grasping the principles involved. Extreme conciseness, although admirable in a reference

ONE



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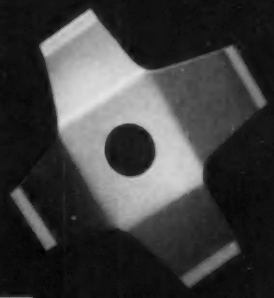

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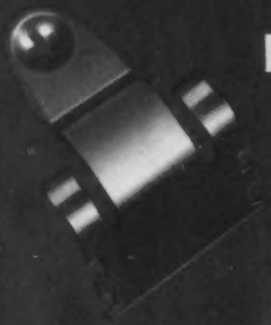

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handbook, is not desirable in a first textbook for undergraduates in any subject. Clear statements with ample explanations and a free use of solved illustrative problems are needed.

The physical behavior of stressed bodies has been emphasized, as well as the mathematical expression of this behavior. The ultimate purpose of a course in mechanics of materials is to prepare the student for an eventual clear understanding of machine and structural design. From the beginning, therefore, the student is encouraged to think of the realities of the situations with which he is called on to deal. Unusual attention has been given to outlining the principles that govern the determination of allowable stresses.

In addition to developing as clearly as possible the simplified expressions on which most engineering design rests, the limitations of these expressions have also been carefully noted and discussed throughout.

Both the double integration of the elastic curve and the area-moment method of deflection have been presented, so arranged that either method can be used in whole or in part.

A feature of the text is the large number of carefully designed problems. To stimulate the student's interest many of these problems have been based on actual well-known engineering structures and machines. The problems culminate in a group of "comprehensive problems," which form the final chapter. The solution of each of these problems requires the application of a number of principles drawn from different parts of the text.

Procedures for Experimental Metallurgy

A. V. SEYBOLT, *Research Assoc., Metallurgy Research Dept., Research Lab., General Electric Co.*, J. E. BURKS, *Mgr., Metallurgy Section, Knolls Atomic Power Lab., operated for the Atomic Energy Commission by General Electric Co.* 6 x 9 *in.*, 340 *pp. Published by John Wiley & Sons., Inc.*, 440 *Fourth Ave., New York* 16, *N. Y.*, $7.

Although much of the recent progress made in understanding the behavior of metals and alloys has resulted from the increasing interest evidenced in the field by physicists and physical

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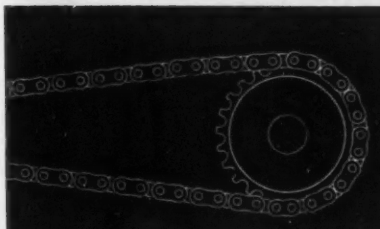

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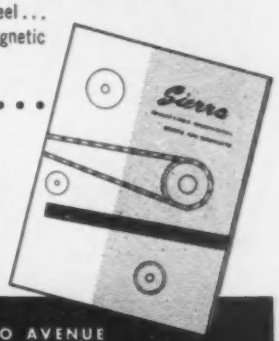

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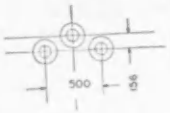
problem Set three rivets simultaneously in small triangular pattern:



Space Between Rivet Heads .015 and .218 — Rivet Head Diameter: .281" — Rivet Length: 5/8" — Work: Stack of 13 components

solution

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chemists, it rarely occurs that such investigators new to the study of metals possess enough of a familiarity with the metallurgist's tools and methods to make their experiments with minimum effort. The primary aim of this volume is to describe most of the important laboratory techniques now used, with enough elaborative detail to allow anyone familiar generally with physical and chemical principles to carry out the unit operations discussed.

Investigational techniques such as microscopic examination, x-ray diffraction methods, thermal analysis, and mechanical testing are purposely omitted because of the satisfactory monographs on these subjects.

The preparation of metal samples up to the point of making observations on the properties of the metal is the guiding principle or theme of the book, including: the steps from preparation or selection of the base metal to be used through principles of alloying, melting without contamination, casting, fabrication into rod, sheet, or wire, and heat treatment to obtain a desired structure.

Also included are chapters on: methods of obtaining high temperatures, and measurements of such temperatures; refractories; controlled atmospheres; powder metallurgy; and preparation of metal single crystals.

Personnel Management

WALTER DILL SCOTT, *President Emeritus, Northwestern University, Pres., Scott Co.;* R. C. CLOTHIER, *President Emeritus, Rutgers University, Vice-Pres., Scott Co.; and* W. R. SPRIEGEL, *Prof. of Managament, Dean of College of Business Administration, University of Texas.* 6 x 9 *in.*, 690 *pp. Published by McGraw-Hill Book Co., Inc.,* 330 *West* 42 *St., New York* 36, *N. Y.* $6.50.

This work has a proven record of success dating back to 1923 when the first edition was published. Since that time the authors have periodically prepared new editions to keep the information up to date. This new fifth edition was completely revised around the results of a survey made of 629 of the leading companies in the U. S. regarding the status of personnel management.

In this edition the authors assume

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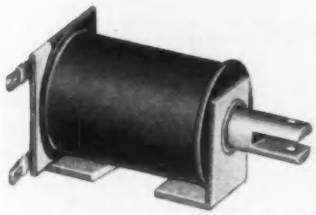

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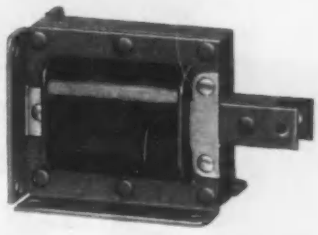


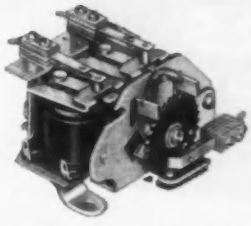
Adjustable Stroke in Inches		1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8
Lift in Ounces	Int. Duty Type	15	10	8	7	6½	6½	6½	6	5½	4½
	Cont. Duty Type	5½	4	3	3	2½	2½	2½	2½	2	2

OPERATING DATA

Volts 60 Cycles	Intermittent Duty Type		Continuous Duty Type	
	Ohms	Amps	Ohms	Amps
6	.42		1.25	
12	1.7		3.23	
18	3.23		7.53	
24	6.46		15.22	
36	13.1		37.5	
115	171.6	0.2	392.4	.074
230	675		1555	

Average power requirements { Intermittent duty type 27 V.A. / Continuous duty type 9.5 V.A.

Wt. 3½ oz.



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Adjustable Stroke in Inches		1/8	1/4	1/2	3/4	1	1 1/4	1 1/2
Lift in Ounces	Int. Duty Type	110	85	70	78	91	95	68
	Cont. Duty Type	65	45	40	46	55	58	40

OPERATING DATA

Volts 60 Cycles	Intermittent Duty Type		Continuous Duty Type	
	Ohms	Amps	Ohms	Amps
6				
12			.24	5
18	.34	8.	.54	3.3
24	.56	6.	.94	2.5
36	1.0	4.4	1.7	1.8
117	11	1.4	18	.520
230	45	.73	93	.240

Average power requirements { Intermittent duty type 123 V.A. / Continuous duty type 43.6 V.A.

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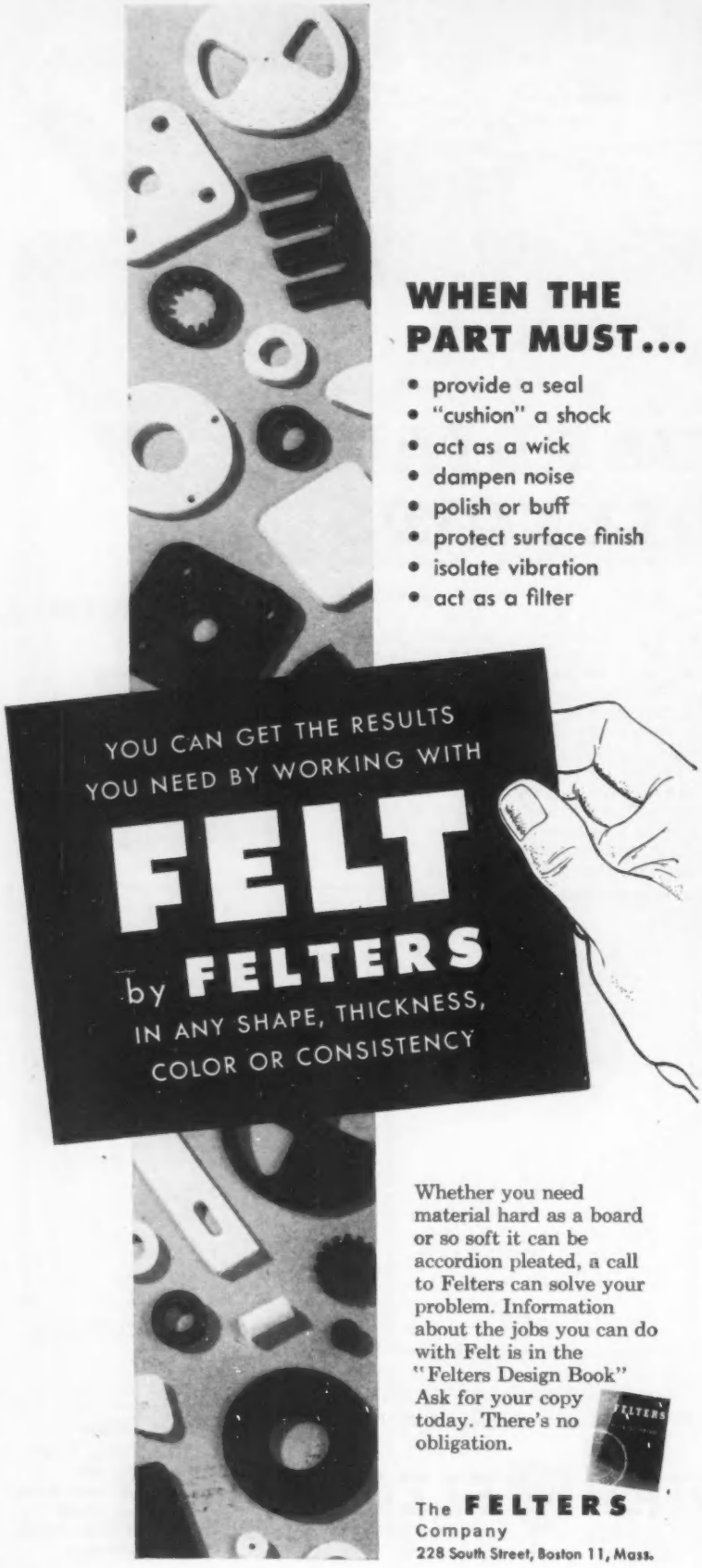
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a mutuality of interest between employer and employee, and also assume that the customer and the public have an interest in equitable rates, satisfactory working conditions, reasonable prices and profits through service.

The book is for college and university students as well as operating personnel men. Chapters can be omitted without loss of continuity.

The previously mentioned survey which appears in the index, covers techniques of employment, maintenance, wage payment, employee security, and research and control. The appendix also shows the trend of many phases of personnel management for the years 1930, 1940, 1947 and 1953 together with material on merit rating and communications.

A new chapter, Personnel Management as a Coordinating Function, has been added, and there are 75 new illustrations.

Fluid Mechanics

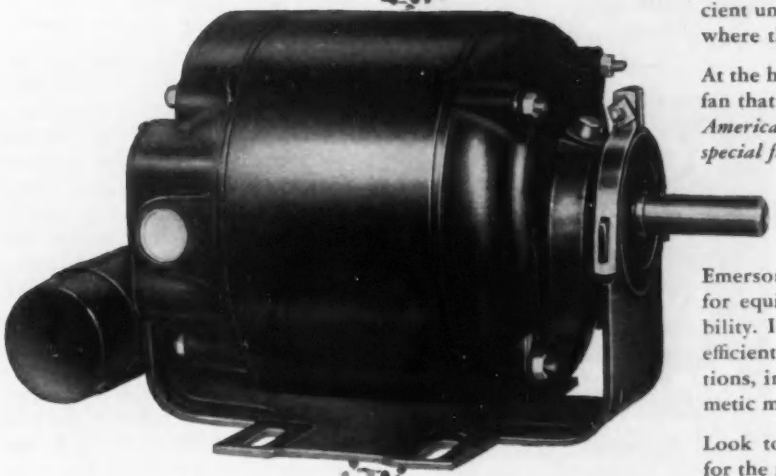
K. VENNARD, *Professor of Fluid Mechanics, Stanford University.* 6 x 9 *in.*, 401 *pp. Published by John Wiley & Sons, Inc.*, 440 *Fourth Ave., New York* 16, *N. Y.*, $5.50.

This third edition follows the same approach to the subject which distinguished this book in two earlier editions. The methods of fluid mechanics are analytical, rational and mathematical rather than empirical. Here the author concerns himself with those basic principles which lead to the solution of numerous diversified problems, seeking results which are widely applicable to similar fluid situations.

This book is intended for the beginner who knows the principles of basic mathematics and mechanics but has had no previous experience with fluid phenomena. The author presents his subject with these objectives in mind: the reader must follow theoretical developments, build imagination in visualizing physical phenomena, and be able to think his way through problems of theory and application. As an aid to the attainment of these aims, the book omits subsidiary conclusions, applies first principles to specific problems, and includes illustrative and numerical examples to assist the reader in overcoming conceptual difficulties.

In order to make this edition more

It tells heat where to go!



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useful, the author has extended its topical coverage by about 10 percent. Thoroughly revised, the book includes a new introductory chapter of generalizations on the subject of one dimensional fluid flow. Three hundred new problems have been added: there is a total of 873 problems in this edition as compared to the 700 included in the earlier work.

U.S.A.F. Machinability Report, Vol. 3—Titanium

Written by JAMES VAN VOAST, *Test work by Metcut Research Associates. 7 x 10 in., 153 pp. Published by Curtiss-Wright Corporation under contract with U.S.A.F.* $4.60 (*approx.*).

Chapters cover the following processes: turning, milling, routing, drilling, tapping, abrasive cutting, hacksawing, belt grinding and surface grinding. The three machinability reports, sponsored by the United States Air Force, are an important part of industrial planning for defense mobilization. This third report differs from its predecessors in that a new engineering metal is involved. Previous reports dealt with the improvement or existing machining methods for irons, steels and high-temperature alloys. This book discusses the machining of a family of materials that have not yet been in high production.

While the tool-life data in the preceding volumes was at a high level of refinement and stressed the importance of careful control of heat treatment and microstructure, this work must start at the elementary level. Exploratory tests to confirm or disprove the early indications were made. Detailed and controlled "basic" tests of many types to learn as much as possible about the behavior of titanium during machining were made. A wide variety of tool materials and setups were tried. Many special techniques were investigated in the hope of finding a simple solution to the peculiar difficulties in machining titanium.

The program consisted of conventional setups under the more promising conditions and the testing of a wide range of speeds and feeds for the obtaining of commercially-useful tool-life data. Speed and feed recommendations, together with suggested tools, tool angles and types of cutting fluids are given for machining operations.

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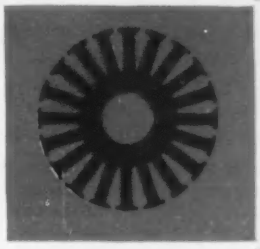

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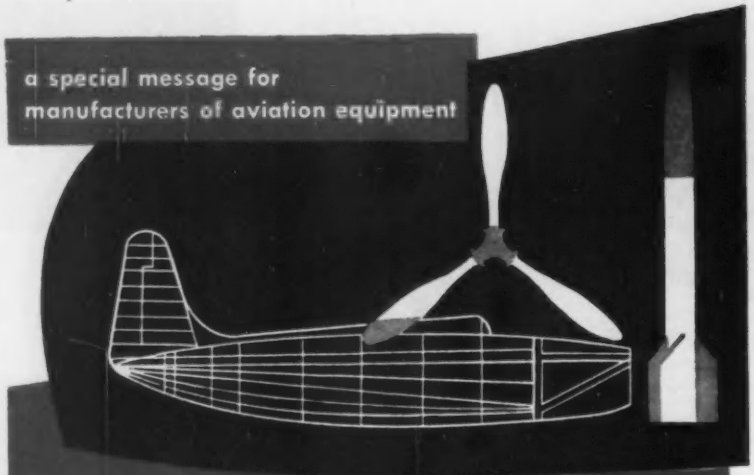

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OUR READERS SAY

Letters should be addressed to The Editor, *Product Engineering*, 330 West 42nd St., New York 36, N. Y.

FTC on Water Conditioning "Gadgets"

To the Editor:

A short time ago we received permission to reprint the editorial which appeared under Perspectives—Design and Development, *Product Engineering*, November 1953.

. . . We thought that you would be interested in receiving the Federal Trade Commission's press release and complaint against [a company manufacturing one of the water conditioning gadgets mentioned].

You undoubtedly will wish to make your readers aware of the recent FTC action. . . . —GEORGE H. KLAUMB
Culligan, Inc.

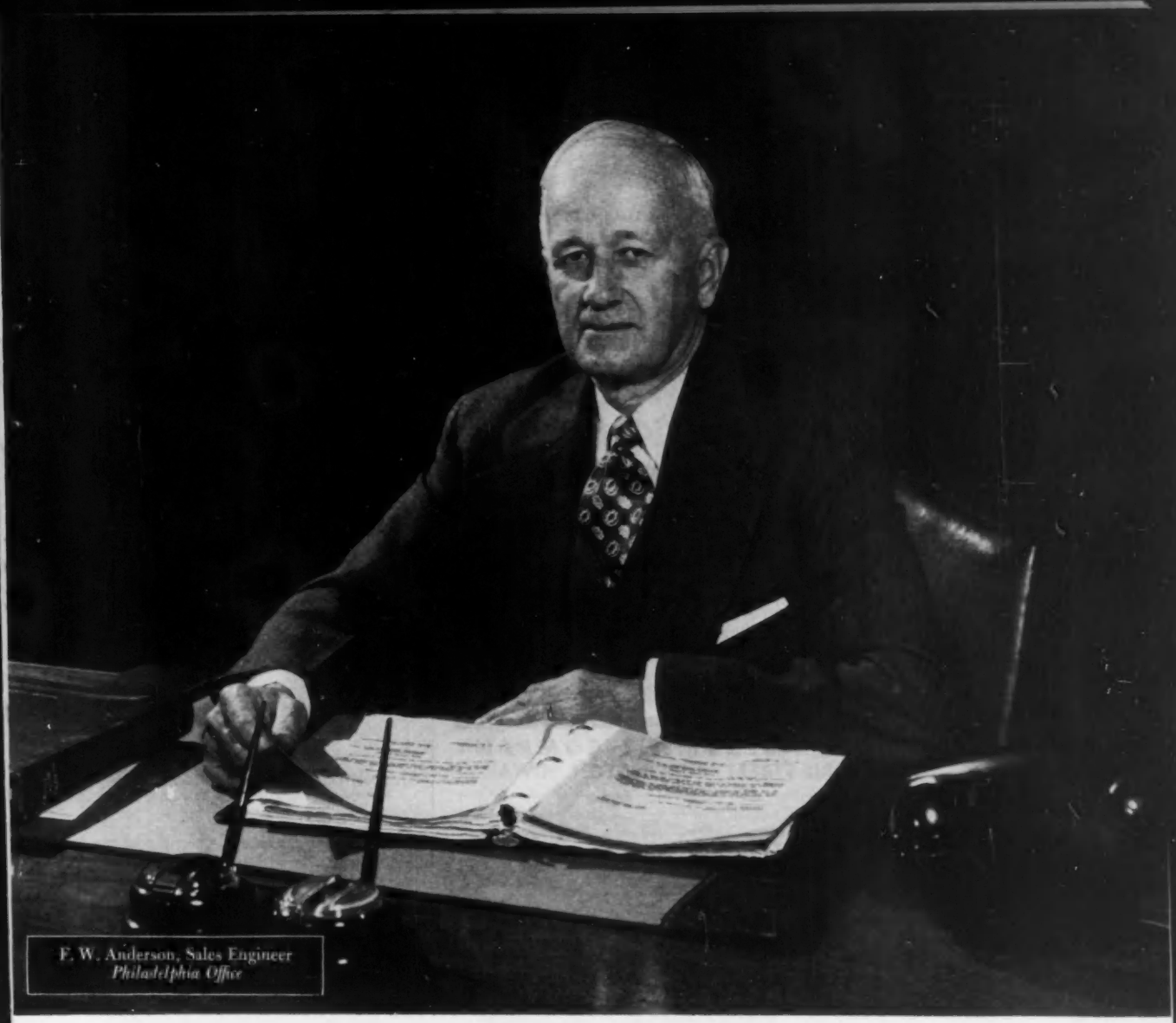
Ed—Our thanks to Mr. Klaumb for calling this to our attention. According to the Federal Trade Commission complaint, advertising claims that the water conditioner "makes hard water feel, taste and act softer" . . . without the use of chemicals, are "false, misleading, and deceptive." The release stated that the respondents have been granted time to answer the complaint, and an examiner has been assigned to conduct a hearing on the case.

How Quantitative Can Quality Be?

To the Editor:

I have long read your editorials. In my experience new, forward thinking ideas are slow in adoption. It has been my feeling that slow progress possibly results from the fact that those now in top positions in industrial power show little enthusiasm for changes which might render their fund of experience less valuable. In consequence, the young and more progressive groups of engineers find considerable difficulty in obtaining opportunities to get acceptance for their ideas. This also applies to young organizations.

No means exist by which the abili-



F. W. Anderson, Sales Engineer
Philadelphia Office

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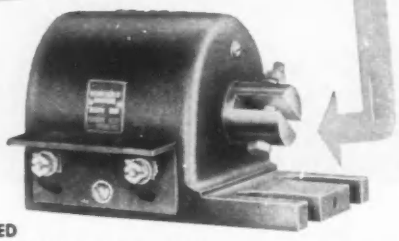

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ties of a group can be judged. There is no respected organization which can review a new organization and give it a sort of "qualification rating" such as is done in financial matters by Dun and Bradstreet. It would appear that an approval equivalent to the "Good Housekeeping Seal of Approval" with a rating might help tremendously towards encouraging valuable new organizations and encourage the obsolescense of useless older ones.

—EDWARD BENTLEY
Waltham, Mass.

Ed—What Mr. Bentley proposes is extremely idealistic. The great problem would be to find those minds that are qualified to pass judgment on the qualities of a service to be rendered on a subject that is still to be determined. In other words, although it is easy to establish a rating based upon the numerical quantity of a bank balance or a dollar volume of business, it is impossible to express service qualities by numbers.

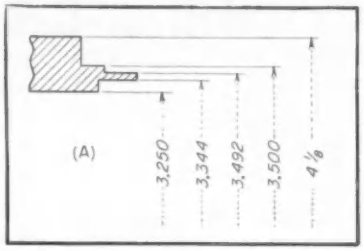
Simplified Drawing Aids

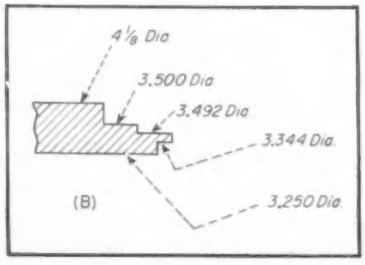
To the Editor:

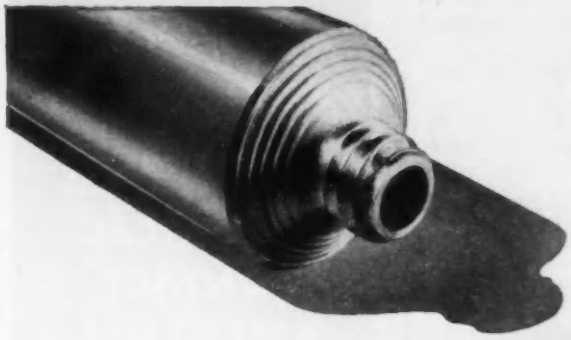
This is a suggestion I wish to make in connection with the dimensioning of working drawings.

. . . Where several close diametrical dimensions are to be given, mistakes are often made because of the closeness of lines defining diameters, (A).

Instead, if diametrical dimensions are spaced further apart, (B), the advantages gained would include less







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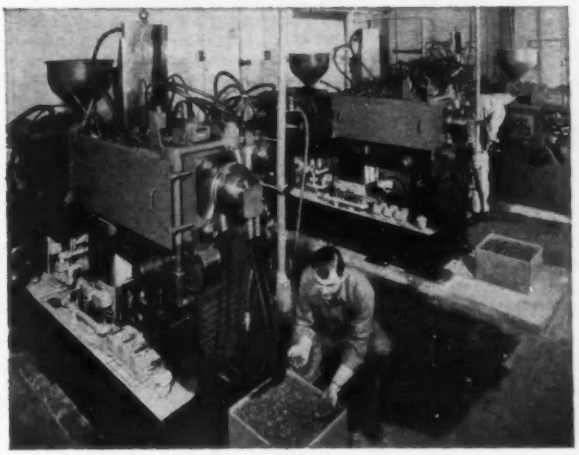

Tube caps are another item that's profiting from Fellows full-automatic molding machine performance, where keeping the hopper filled is all the normal operating attention that's required.

At the Sun Tube Corporation in Hillside, N. J....32-cavity automatic degating molds ... a different size cap on each machine... provide the right combination.

If you're interested in learning the facts of Fellows 'automatic molding' and what it means to your profit picture—there's a plastics machine specialist in the Fellows office nearest you.

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Plastic precision Extrusions made to your exact specifications.

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work, easier reading, and less chance of errors.

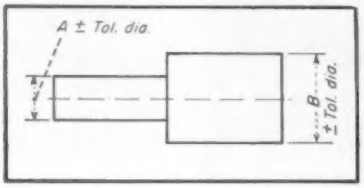
Lines pointing to the various diameters could be drawn free hand or with a straight edge. —JOHN KOSAR
Anchor Engineering Co.

To the Editor:

mentals and interpretations.

It seems that an unwritten law is in many ways abused and misused. I refer to reading of an engineering drawing, in which each dimension is a sentence and each line a paragraph. In my experience, I have been told that to read a print in this manner is in accordance with good craftsmanship or workmanship. For example when no angle is specified it is considered to be 90 deg with no tolerance, even though other angles do appear having a general tolerance. Also, the pitch diameter of a gear does not take a tolerance, yet I maintain that these are basic fundamentals and should be treated as such.

Another of the unwritten laws is that concerning concentricity. I have tried in vain to find some book which will make a definite statement as to how concentricity can be figured or interpreted when no concentricity note appears on a drawing. Concentricity, according to Webster, means "state of having a common center." I maintain that concentricity is held to the tolerances of two or more diameters, as illustrated below.



For Shafts:

Concentricity: zero when both diameters are on high limits

For Bores and Counterbores:

Concentricity: zero when both diameters are on low limits.

The allowable maximum concentricity: total tolerance of A diameter plus total tolerance of B diameter.

The total indicator reading involves, therefore, taking a space equal to the high limit of both diameters having zero concentricity and allowing a piece on the low limit of both diameters being out of concentric to the amount of the high limit in that space.

If it is required to increase or decrease the concentricity, this is done by a note, thus, diameters marked O must be concentric within (amount) T. I. R. —ELMER A. GRUESCHOW
Racine, Wisc.

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A HEAD START
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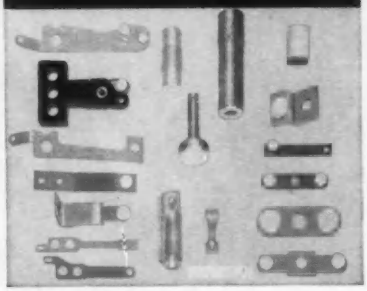
ELECTRICAL CONTACT ASSEMBLIES



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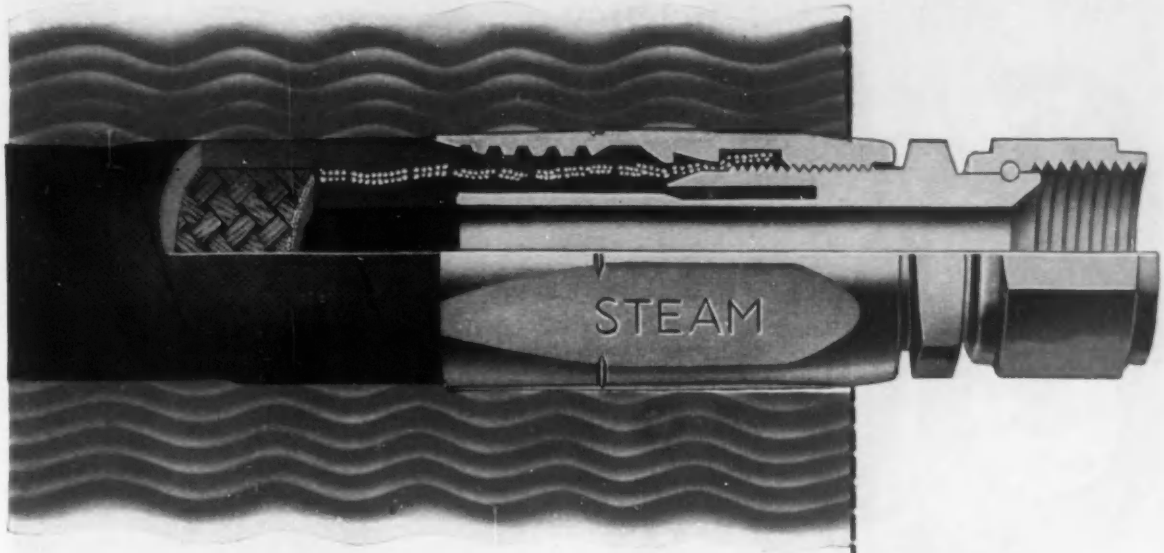

Now . . . a steam hose line built for extra l-o-n-g life! The secret is in Aeroquip's reusable "*little gem*" fittings that assure positive attachment to the hose and never need re-tightening once assembled. The knife-like spur (1), see diagram, of the "*little gem*" separates the inner tube from the wire braid; clamping action (2) is exerted on reinforcing braid only; and a lip seal (3) is formed by the end of the inner tube in an annular chamber. The "*little gem*" is a streamlined, compact fitting with no bolts or protruding surfaces to hinder handling. In perfect combination with Aeroquip burst-proof steam hose, it offers greater efficiency and maximum safety. *Truly another Aeroquip first in better hose lines!*

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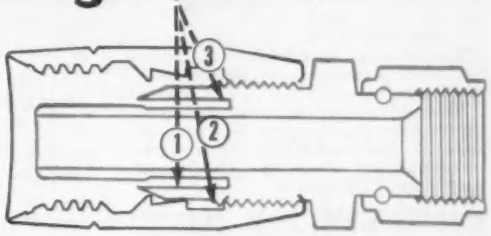

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In a wide range of applications, Curtis Joints offer the designer assurance of long life and trouble-free performance — because they are quality-controlled at each step of manufacture.

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Organization of Engineering Sections for Efficiency

ROBERT E. MALONEY

Control Engineering Corporation
Norwood, Mass.

DEPARTMENTAL SET-UP of engineering sections in small and medium size companies takes an almost infinite variety of shapes and forms, some of which are more efficient than others. The person responsible for the proper functioning of an Engineering Section or Department can generally determine whether or not he has an efficient, well knit group by asking himself these four simple questions:

The expense of hiring and training a new engineer (not to mention the uncertainties involved) is too well known to elaborate on here. This, plus the fact that good engineering talent is getting scarcer in most parts of the country, make this a very serious problem. The situation can however be alleviated if the problem is recognized and met head on.

If the Engineering Department is not the heart of a successful manufacturer, then what is? Salesmen are needed to sell and machinists are needed to produce, but the best salesman in the business can not sell an inferior product and the best machinist cannot economically produce with over-toleranced dimensions and a constant stream of engineering change notices hampering him.

The elimination of petty jealousies, hoarding of information, and "passing the buck" is a necessity for a smooth working, efficient Engineering Department.

All too often the Engineers are thought of as a group of ultra-theoretical, pseudo-genius pencil-pushers with no appreciation for practical manufacturing problems.

High Turnover

A review of the cases of those engineers, designers and draftsmen who have left the company in the past will

DOWNRIGHT DEPENDABLE

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THE LEWELLEN DOUBLE-BLOCK, UNITIP BELT—keeps tension at a minimum on belt, bearings, and shafts. Contoured lateral blocks are bolted and riveted to an impregnated, plied belt body at closely spaced intervals. Lightweight splice plates are pinned, riveted, and cemented to belt ends. Pin heads interlock with mating splice plates to form a strong, compact splice. Assembled belt is machined and single tips are cemented and pinned to block ends. Here is what it takes in a belt to give dependable performance under all load conditions.

AND THESE DISTINCTIVE FEATURES—FLEXIBLE LEVER & LINK SUSPENSION . . . thrust bearing load equally distributed on every ball in the bearing, at all speeds and positions, and while changing speeds. SIMPLE, POSITIVE LUBRICATION SYSTEM for disc hubs, keys, and shaft.

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Open or enclosed, vertical or horizontal Variable-Speed Transmissions in all sizes from fractional h.p. to 60 h.p. . . . Variable-Speed Motor Pulleys in all ratings from fractional to 7½ h.p. Speed range, 3 to 1 for all pulley sizes. (One size—2¾ to 1.)

Service in variable-speed control exclusively for more than 50 years. May we help you?

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. . . IT SPRINGS OPEN!

It's Resilient!

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You benefit by that difference . . . in packings that last longer and produce tighter seals. They just don't seem to wear out, users tell us.

This Houghton development combines the best features of both leather and rubber packings. It gives you leather's strength, low friction, and long life, plus the non-porosity and resilience only rubber provides. And add to this a new design feature that has revolutionized packing tradition.

That's VIM 1243-3, the biggest advance in cup packings in the past twenty years. Ask the Houghton Man, or write E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

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Here is an example of Flow Regulators used as standard equipment by Automatic Transportation Co. in their Skylift trucks. More and more manufacturers incorporating hydraulic equipment in the products they manufacture are finding that WATERMAN FLOW REGULATORS simplify circuits, reduce weight, space and cost while providing automatic flow regulation.

Available in a range of sizes and a variety of models to take care of your requirements.

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Waterman ENGINEERING COMPANY
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reveal two outstanding facts. First, some of these men are chronic job-hoppers and should not have been employed in the first place. This does not mean, of course, that valid reasons for changing jobs should be a cause for failure to hire a prospective employee. It does mean, however, that interviewers should be wary of those individuals who have held six or eight different jobs in the past couple of years. The remainder of those who have left in the past will, to a great extent, be designers and draftsmen who have had nothing in the way of encouragement to create and to advance. Sitting at a drawing board eight or nine hours a day and drawing the lines of someone else's creation can be just as boring and tiresome as the work done by an unskilled laborer on an assembly line. Often times the only way a draftsman or designer can get the opportunity he seeks, is by changing jobs. The answer is an inter-departmental organization that allows for the engineers, designers and draftsmen to work in close harmony and to pass information and skill on down the line. Project engineers are responsible for the men under them and are themselves directly responsible to the Chief Engineer. Reporting to the project engineer is a junior engineer or designer, who in turn works with a layout draftsman-checker. Below him are the detail draftsmen.

The detail draftsmen and possibly the layout draftsman-checker should be rotated occasionally to allow them to benefit from the specialties and varied knowledge of the engineer. They may also be loaned from one project engineer to another as the work loads indicate.

A new project should begin with a meeting of all to be concerned from the project engineer to the detail draftsmen. The draftsmen thus feel that their ideas and opinions will be weighed and valued and if impractical, they will be told why; as much responsibility as possible should be delegated to those on the lower rungs. Only by shouldering responsibility will one ever learn to shoulder it and only by doing the job will confidence be gained.

Promotions should be filled from within the organization almost exclusively. This means that most of the outside help employed will be Detail Draftsmen who are studying Engineering evenings or who intend to do so. Financial assistance can be offered to all as an inducement to further ad-

Which is the CleCap?

...the outsize one that nobody else makes

One of the advantages CleCap customers enjoy is the knowledge that when they want some of those BIG cap screws, the chances are 9 out of 10 we can ship them the same day.

CleCap makes 'em from ¼" to 2½" diameters, any length you want—ferrous and non-ferrous—and we stock a lot of unusual sizes, nearly 10,000 different items last count.

That's another reason for dealing with *The* cap screw specialists of the country. You also get unbeatable top-quality fasteners . . . PLUS a CleCap crew that has a long-made rep for "busting a leg" to get you what you want exactly when you want it.

What happens to your profits when late deliveries hold up production lines? Put your cap screw needs up to CleCap . . . and relax!

The Cleveland Cap Screw Co.

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Hex Head Cap Screws—Bright and High Carbon Heat Treated Steel, Brass, Silicon Bronze, Stainless Steel; ¼" to 2½" dia.

Socket Head Cap and Set Screws—Plain and Knurled ¼" to 1½" dia. Also Flat and Button Head Styles.

Flat Head Cap Screws: ¼" to 1" dia.

Fillister Head: ¼" to 1¼" dia.

Set Screws—Square Head: ¼" to 1½" dia.

Milled Studs: ¼" to 1¼" dia.

Place Bolts: ¼" to 1½".

Structural Bolts to ASTM Specification A325

Tractor Bolts

Special Hot and Cold Headed Parts

Facilities to make larger diameters than listed.

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Originators of the Kaufman DOUBLE EXTRUSION **Process**

To seal glass safely, use this cork-and-rubber tape

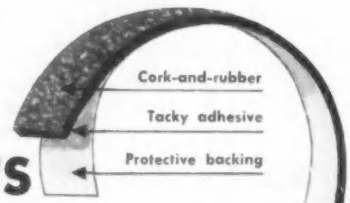
To keep glass breakage down, many makers of automatic venders, parking meters, and similar equipment use Armstrong's resilient DK-153 Tape to seal their "windows."

DK-153 provides a springy cork-and-rubber cushion that absorbs shocks and vibrations and prevents rattles while it keeps out dust and moisture.

A pressure-sensitive adhesive on the back makes DK-153 Tape easy to apply. You just peel off the cloth backing and press into place. It sticks instantly to any clean, dry surface.

DK-153 Tape is also used for packing fragile parts to prevent breakage and scratching in shipment, as an anti-squeak material in fenders and bus bodies, and as an anti-skid base for phones and office equipment.

You can get DK-153 in several widths and thicknesses, in sheets, ribbons, rolls, and die-cut shapes. For samples and more information, write on your letterhead to Armstrong Cork Company, Industrial Division, 7305 Irvin St., Lancaster, Pa. Available for export.



ARMSTRONG'S
DK-153 TAPE

vance themselves through evening graduate or undergraduate studies.

Quality of Designs

A product is only as good as the men who design it. By rewarding these men, who design, in a material way *and* in a descriptive way through pay increases and well chosen compliments, an incentive to tax the brain and to put in that extra bit of overtime is achieved. No one is more pleased with a job well done.

Technical publications should be made available to all—not to be read only during lunch hour or at home, but available in the office to be glanced over and studied during slack work hours. One man can be delegated—in the absence of a librarian—to subject-index the various articles into a file for reference purposes. The good engineer not only has a storage space full of knowledge in his head, but possesses the faculty for being able to obtain quickly facts and formulas and Design Data pertinent to his present project. Why not make it as easy as possible for him to do this. The expense of maintaining an Engineering Library is negligible compared with the benefits obtained.

Co-operativeness

Harmony and teamwork are as important in business as they are in athletics. Far too many engineers, especially old timers who graduated from the school of hard knocks, will go to great lengths to keep their vast experiences and valuable knowledge from the young engineer whose only claim to his title is his B.S. They obviously do not recognize that everyone connected with the firm benefits from a good design and that they are cutting no ones throat but their own in the long run. Personal praise and appealing to the man's sense of company loyalty will straighten out a great many. As regards the remainder there are two alternatives : 1) Place the man on long term one-man projects where his knowledge of the product will be of great value or 2) Get rid of him. The latter, of course, is harsh and should be avoided if at all possible.

Social activities should also not be under-estimated. Inter-departmental bowling leagues, golf tournaments, occasional parties, etc. should be company sponsored and encouraged.

A monthly meeting may be called by the Chief Engineer to discuss pertinent projects and problems with his

MAXITORQ

automatic

OVERLOAD RELEASE

CLUTCH

To designers and manufacturers of high-speed automatic machinery, Carlyle Johnson offers practical engineering recommendations for applications of this protective power transmission unit.

Let's consider, for instance, a can or bottle labeling machine . . . when an accidental overload shock occurs. Labels go flying all over the place, cans or bottles gang up and are dented or broken, the driving mechanism is jammed . . . and all that costs money and down-time.

But not if your original power transmission is controlled by the Maxitorq automatic Overload Release Clutch, which is manually adjusted to transmit the normal running load and instantly disengages into neutral when the overload strikes. With a minimum of clean-up, the clutch is re-engaged . . . and all is well.

Overload Release Cups (note the cam construction) are the means by which the clutch is connected to the driven or driving member. We make them at relatively low cost . . . and can also supply hub, ring, flange, or cut-off coupling types to suit your specific conditions. Clutches standardized in 6 sizes, ¼ to 5 H.P. @ 100 r.p.m.; working torque, 13 to 263 ft. lbs.

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SPEAKING

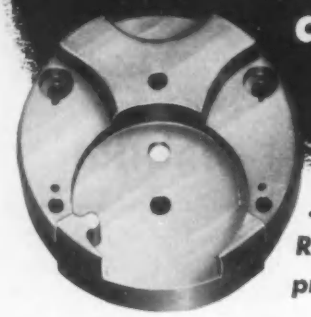
There are quite a few types of clutches but, within its capacity, the Maxitorq Floating Disc Clutch is not excelled in applications for which it is intended. The Carlyle Johnson Machine Company is celebrating its 50th anniversary of clutch manufacture. Throughout those years, our engineers have developed new design features, more and more compact construction, improved wearing qualities, and better machining practices for maintaining reasonable costs.

Perhaps the outstanding design feature is the patented "Separator Springs," a definite improvement that moved multiple disc clutches up to the front line. Used between each pair of inner discs, they spread them endways with an accordion action, so that light may be seen between all discs when the clutch is in neutral. Therefore, there is no drag, no abrasion, no heating. The discs actually "float" or ride free when the clutch is in the neutral position.

Carlyle Johnson's method of finishing the engaging faces of the discs assures flat, true surfaces. This means that under engagement there are no high or low spots . . . the entire area of the surfaces has an evenly distributed contact. Obviously, disc service life is greatly extended. Such refinements are the result of continuous study by our engineers to make and keep the Maxitorq name high on the list of machine and product designers for their original equipment for control of power transmission.

Your problems are in good hands if you put them up to our engineers for solution. We've traveled the country over to check on the best and most practical installations . . . and we're on call whenever a problem arises. Just ask for Frank R. Simon, The Carlyle Johnson Machine Company, Manchester, Conn.

here's how TWIN CITY made $1 do the work of $14



...by casting this Ammunition Rotor Housing at 1/14 of the previous fabricated cost!

Machined from brass in 1943, this rotor housing cost 14 times its present delivery price. Costs had to come down and production had to go up. Could die casting do the job? Several die casters said the small holes in the intricate housing made the job impractical. Costly machining *appeared* to be the only process.

HERE'S WHAT THE JOB INVOLVED:

Cast the rotor housing with a diameter of 1.307″-1.310″, a thickness of .486″ and with eleven cored holes in the casting, some as small as .040″. Four .0780″-.0790″ dia. holes and 2 holes .0945″-.0955″ were included. Counterbore cores were necessary. Tolerances had to be maintained and each hole had to be relative to every other point . . . a most exacting job with 41 separate gauging operations.

HERE'S HOW TWIN CITY HANDLED IT:

The die was made in Twin City's own shop. Special tooling was designed to insure uniformity of subsequent impressions. During casting, temperature of the dies was automatically controlled. Millions of rotor housings have been produced *to specifications* at approximately 1/14 of the machined cost at today's prices. Only in a shop where individual attention is given can a job of this kind be successful.

HOW TWIN CITY CAN CUT YOUR COSTS:

Twin City's experience on countless tough jobs, plus its ability and willingness to work with your engineers can help you show *new* profits on the products you make and sell. Oldest die casters in the Upper Midwest, Twin City welcomes the opportunity to show you how precision die casting can pay off for you.

Write for facts or send sample or blueprint. Let Twin City demonstrate its service plus to you!

TWIN CITY DIE CASTINGS CO.

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entire staff. Problems and gripes can be aired, suggestion discussed and resolved, and new engineering trends and developments talked over.

Shop Respect

Knowledge of machine shop procedure is necessary if the engineer is to temper his specifications with reason and intelligence. For those who have had no practical shop experience, the only thing I can say is either go and observe, or take a short general machine shop course in some good technical school. When the opportunity presents itself to assemble your own proto-type, or to be present when the parts are being made, don't let it slip by. If the machinists are working Saturday mornings or evenings through-out the week, drop by the plant for a couple of hours now and then, and the knowledge that you pick up will be worth the effort.

Management can aid greatly, of course, by giving a short training course to its engineering staff and by encouraging their presence in the shop. They should also impress upon the staff, however, that only one engineer in a hundred is half the machinist as the man on the job. The man who bursts into the shop with a "know-it-all" attitude and a chip on his shoulder is in for more than his share of woe. The machinist takes pride in his work also, and knows, generally, what he is doing. To incur the wrath of the machinists, the bench workers, and the foremen with constant arguing, fault-finding and nonconstructive criticism can write an end to the engineers progress.

The policies and methods suggested above have been applied, for illustrative purposes, to a mechanical engineering department. By substitution of words like "technician" and "laboratory" for words like "draftsman" and "model shop", it could just as well apply to an electrical engineering department.

Management in the past few years has invested heavily in its engineering branch. The investment is proving itself daily and will continue to do so if that investment is wisely used and treated. A horse can be led to water and an employee told not to watch the clock—but neither can be compelled to obey unless they are thirsty—The horse thirsty for water and the employee thirsty for knowledge, achievement and recognizance. This thirst can be cultivated.

Announcing a new line of

DENISON RELIEF VALVES

• LOW PRICE • 2000 PSI • PILOT OPERATED

LOW PRICE

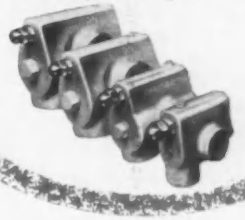
A new line of pilot-operated relief valves with the widest range of pressure regulation of any in use on 2000 psi circuits today. *Yet they sell at an unusually low price.*

ACTS FAST

Being pilot-operated, valve action is fast, smooth and quiet. There's an improvement in efficiency, too, because of low differential between opening and closing pressures.

4 SIZES

½", ¾", 1¼" and 1½". Rated capacities of 10, 20, 60 and 80 gallons per minute.



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COLUMBUS 16, OHIO

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for free Bulletin No. 152. It gives operating characteristics, capacities, sizes and dimensions of the new line of Denison Series M Relief Valves.

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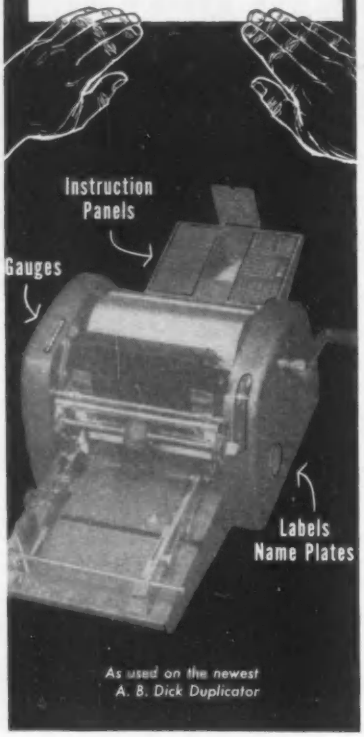

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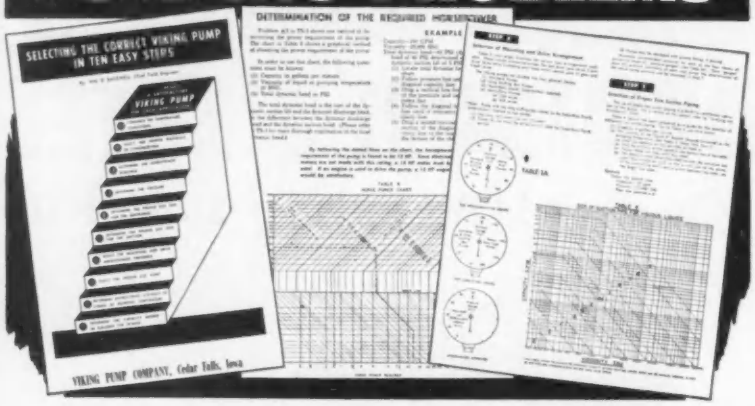

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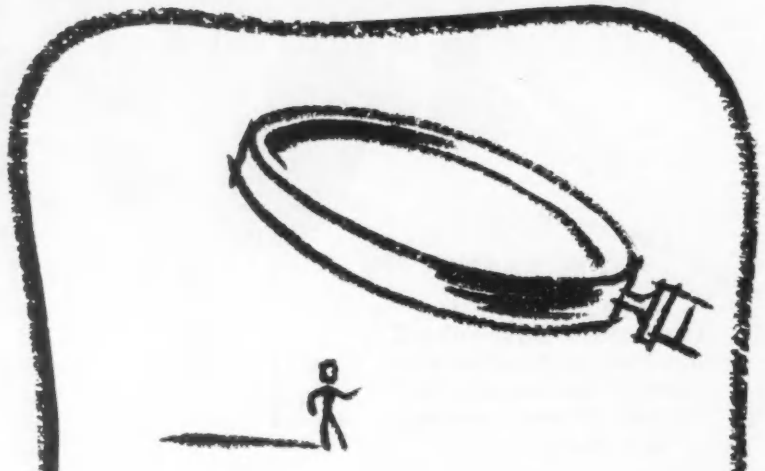

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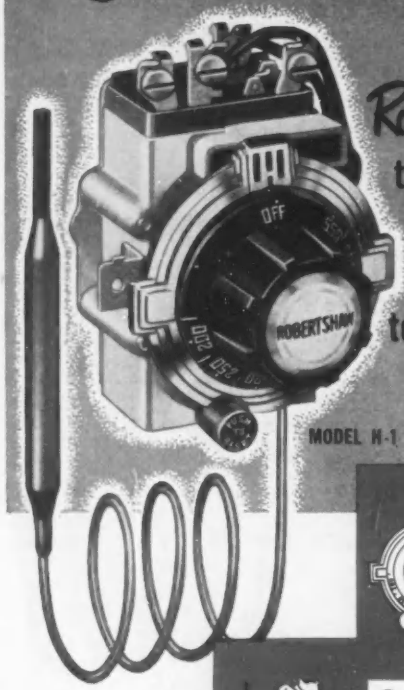

Robertshaw® thermostat with over-temperature cut-out

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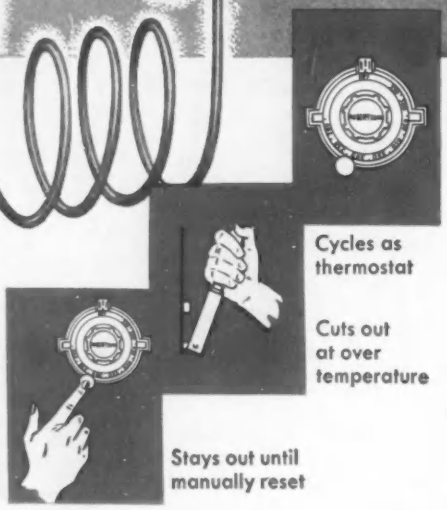

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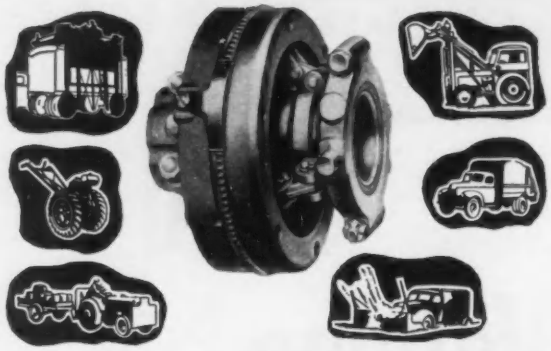

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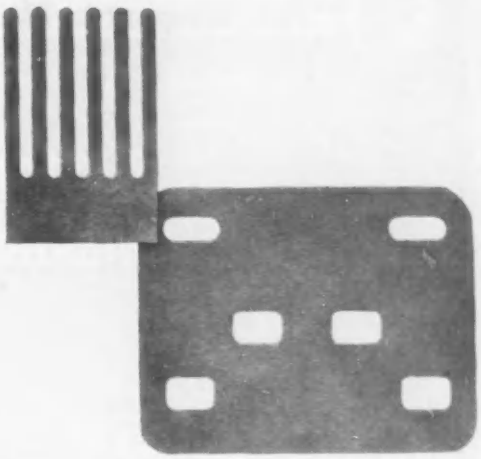

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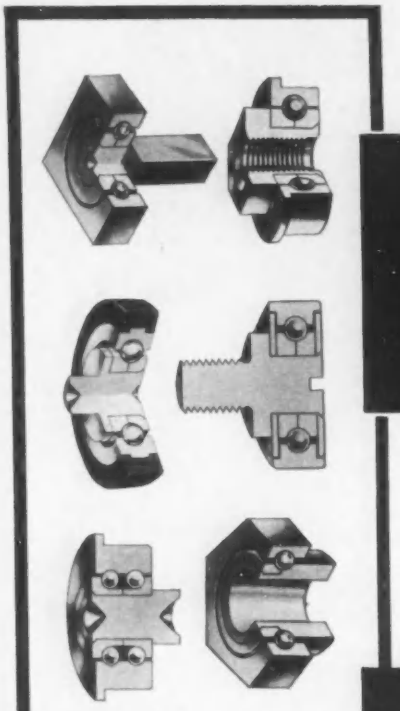

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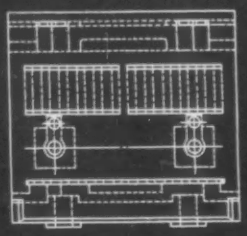

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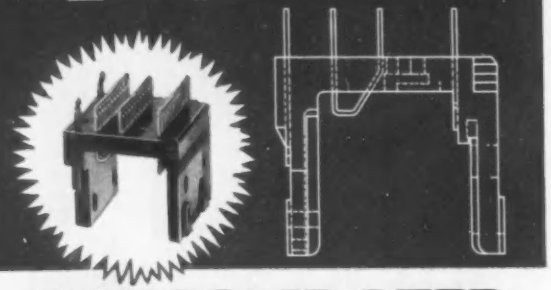

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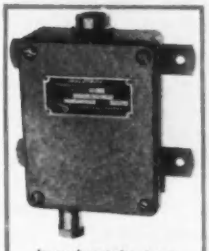
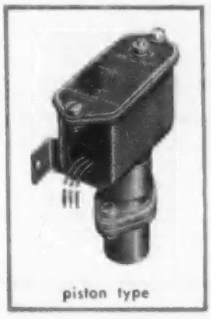

bourdon tube type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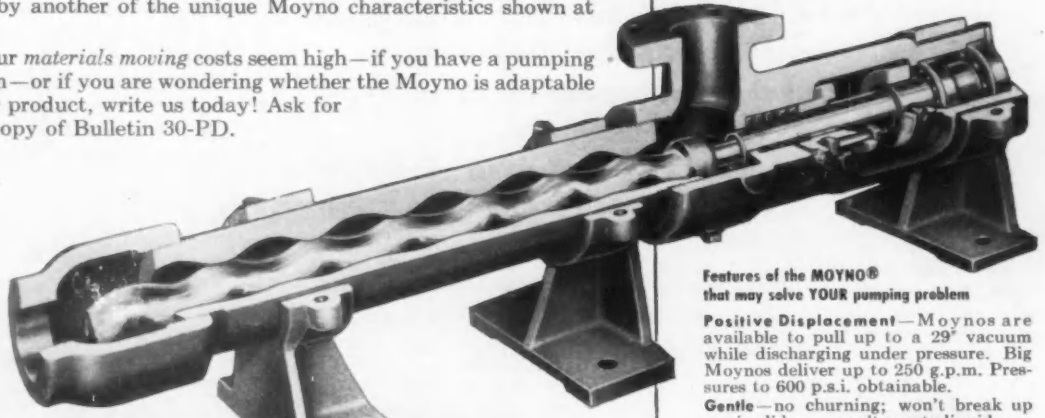

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Electric Temperature Control and Detection Devices

SENSITIVE... *but only to heat*

DESIGNING WITH ALUMINUM

NO. 7

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Advertising Department, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

ALUMINUM FOR DUCTS

NEW RESEARCH DATA SHOWS ALUMINUM PROVIDES REDUCED HEAT AND FRICTION LOSSES

In No. 2 of these information sheets on Designing With Aluminum, which dealt with some of aluminum's thermal properties, mention was made that bare aluminum ducts were more efficient than bare galvanized or metal ducts covered with asbestos paper in delivering hot or cool air. This results from the fact that one of aluminum's useful properties is high reflectivity to radiant energy, and corresponding low emissivity.

Recent research studies by F. W. Hutchinson of Berkeley, Calif., have demonstrated that friction losses in aluminum ducts are substantially less than in galvanized ducts. This means that for the same duct size aluminum will require less power, and hence permit lower operating costs. Or, for the same friction loss, the aluminum duct will be of smaller diameter, thus providing for possible savings both in first cost and through more effective use of building space.

Duct Size Reduced By Using Aluminum

The new data have definite practical significance, as shown in Figure 1. This has been prepared for a heating system using bare aluminum duct with hot air in at 170°F and 100 feet of duct running through a space in which the ambient temperature is 60°F. It combines the influence of reduced friction loss and reduced heat transfer, and shows that substantial savings in duct size can be obtained through the use of aluminum.

The influence of heat loss (or gain in the case of air conditioning) is most important in small diameter ducts with low air velocities, while friction loss has the greatest significance in small ducts at high velocities. The result is that for small to moderate size ducts there is a saving in diameter of from 5% to 12% over the entire range of velocities.

Consider, in Figure 1, the use of a 6" duct with 700 feet per minute velocity: for these operating conditions the bare aluminum duct would be 12% smaller than an asbestos-paper covered galvanized duct. This means that the aluminum duct would handle a smaller volume of air to deliver equal heat at the point of discharge. Further, the velocity in the aluminum duct would exceed that in the other duct, but the loss in head would be the same.

Since the power requirements of an air distribution system depend on volume and head loss, it is evident that in this instance the bare aluminum duct would not only be 12% smaller, but would provide additional saving through lower operating power requirements.

In a series of actual tests it has been determined that the absolute roughness of aluminum duct is about one-third that of galvanized, on the order of 0.00015 to 0.0005. Friction charts developed directly for aluminum show, in comparison to friction charts for galvanized, a reduced friction loss which varies in amount with velocity and with duct diameter.

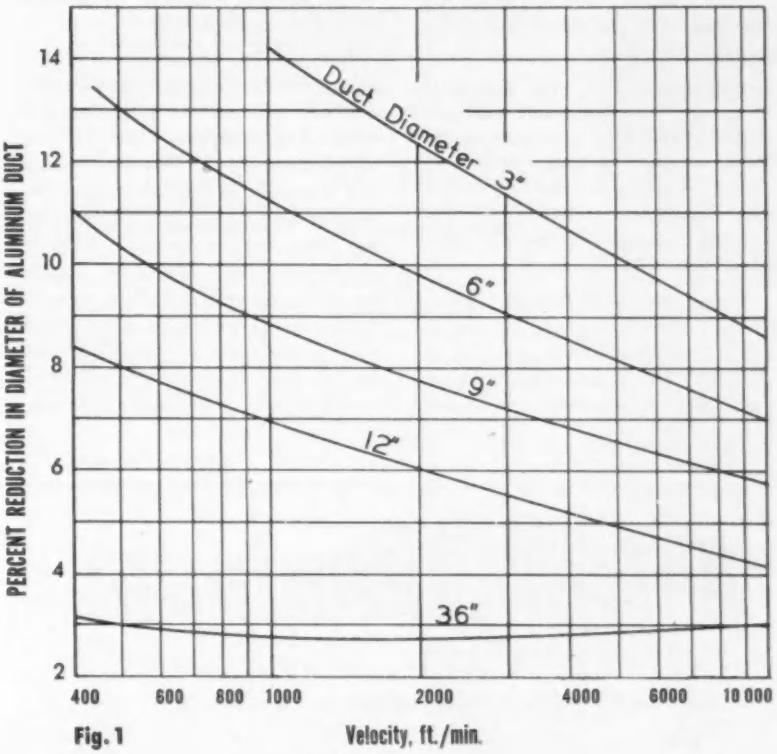

Fig. 1

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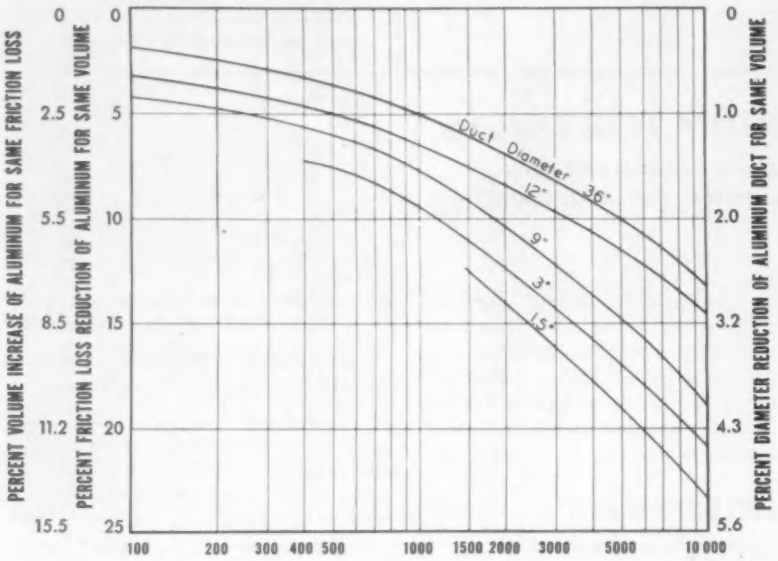

Fig. 2

Friction Most Important At High Velocities

For large ducts at low velocity the reduction in head loss is a few per cent, but small aluminum ducts at high velocity will afford savings in friction loss of 20% and over. This advantage of aluminum is of special significance in view of the increasing trend toward small high-velocity duct systems.

For systems used purely for ventilation or exhaust purposes, where the supply air is neither heated nor cooled, the reduction in size of aluminum duct, as compared with galvanized, is due entirely to the lesser friction loss. Figure 2 provides a means of comparing the two duct materials over a wide range of diameters and velocities, and permits the designer also to determine directly and exactly the comparative advantages of aluminum for any particular duct.

The scale at the far left in Figure 2 gives the per cent increase in volume which can be passed through an aluminum duct for fixed value of the friction loss; this volume increase would permit a corresponding reduction in diameter as given on the scale at the far right. In cases where it is not desirable to reduce the diameter, the aluminum duct would provide a reduction in friction loss as indicated on the inner scale at the left.

For example, a 9" diameter aluminum duct carrying air at a velocity of 4000 feet per minute would have a friction loss approximately 13½% less than a corresponding galvanized duct. For the same friction loss the aluminum duct would carry approximately 7½% more air, and would be approximately 3% smaller.

A 32-page report, "The Design of Aluminum Duct Systems," has been prepared for Kaiser Aluminum by Mr. Hutchinson on the basis of the new data. It presents for the first time a design procedure, including graphical methods, directly and uniquely applicable to aluminum ducts.

Among the charts included in this book are charts giving friction loss per 100 ft. in aluminum ducts as a function of velocity, volume and diameter. They are similar to those which have been regularly used in connection with galvanized installations, but are developed especially for aluminum. Thus they enable the engineer to design directly for aluminum and avoid the necessity for the use of approximate conversion factors.

Copies may be obtained without cost by writing Kaiser Aluminum at 1924 Broadway, Oakland 12, Calif., or through any of the company's sales offices in principal cities of the country.

Additional Aluminum Advantages

The lower heat and friction losses discussed above are not the only advantages to be derived from the use of aluminum duct work in heating, ventilating and air conditioning systems. Aluminum's corrosion resistance contributes to long life and minimum maintenance. Moisture does not cause red-rusting or stains. Its workability and light weight provide for reduced fabrication and installation costs. General practice calls for equal thickness of metal, whether aluminum or galvanized, in duct installations.

Although the advantages of aluminum in this type of application are naturally of most interest to heating and ventilating engineers, architects and those concerned with the construction and operation of buildings, they also provide an outstanding illustration of how aluminum's unique combination of properties make it one of the world's most useful and versatile metals. Assistance or information on individual application, fabrication procedures and the selection of alloys and forms of aluminum may be obtained on request.

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see our catalog in PRODUCT DESIGN FILE or write for copy

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OPERATE SWITCHES	HOLD CHUCKS
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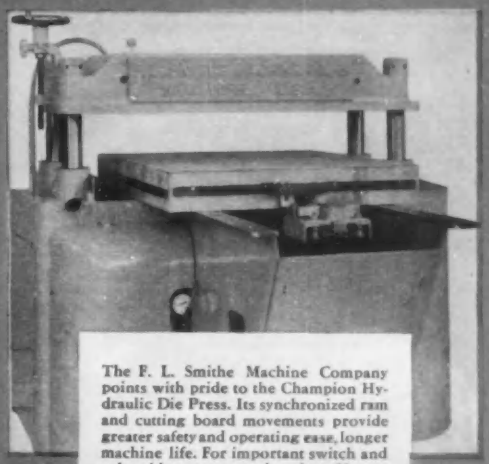
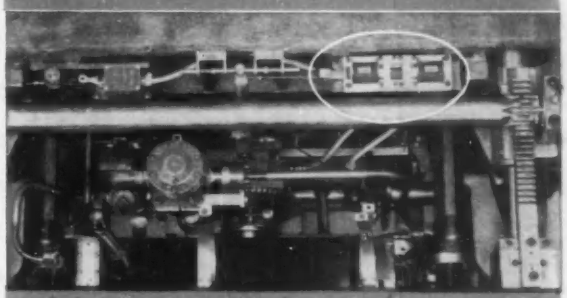
Namco "Stellite"-weld Solenoids are built in sizes with ratings from 2½ to 25 pounds, push or pull, at maximum 1" stroke. We'll be glad to recommend the size and style best suited to your job—ask our engineers to talk it over with yours.

Engineering BULLETIN EM-52 gives details on standard Namco Solenoids.



The F. L. Smithe Machine Company points with pride to the Champion Hydraulic Die Press. Its synchronized ram and cutting board movements provide greater safety and operating ease, longer machine life. For important switch and solenoid components, they chose Namco Snap-Locks and "Stellite"-weld solenoids.



Packaging machines, shearing devices, valves, envelope machines and many others perform better longer with Namco Solenoids. "Stellite"-weld and hard chrome plate bonding on plunger, sturdy construction and highest quality coils make Namco Solenoids long lived, rugged, DEPENDABLE.

ELECTRICAL MANUFACTURING DIVISION

The NATIONAL ACME COMPANY

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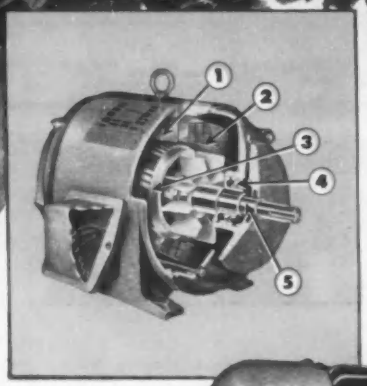
ACME-GRIDLEY
BAR and CHUCKING AUTOMATICS
1-4-6 and 8 Spindle • Hydraulic Thread Rolling Machines • Automatic Threading Dies and Taps • Limit, Motor Starter and Control Station Switches • Solenoids • Contract Manufacturing

It stood up to weather's worst **DOWN UNDER**

...BROOK MOTORS can meet your temperature conditions, too!

Dry swirling dust or penetrating moisture . . . broiling desert heat or below-freezing cold . . . it takes a tough motor to stand up to variable climatic extremes. Famous Brook AC electric motors are *especially built* to the operating conditions found anywhere in the U. S. and in any foreign country. Mica-insulated stator slots and windings are impregnated and baked to resist heat, cold, dust and moisture. Every Brook motor is designed and precision built to meet or surpass NEMA standards. Easily serviced in any shop, parts and motors quickly obtainable everywhere. Ideally suited for original equipment manufacturers, for users of equipment requiring replacement motors, and for products destined for export. Whatever *your* needs, insist on Brook . . . the world's *most respected* motor—built by the world's *most experienced* manufacturer.



1. **Ceramic-coated stator laminations** provide excellent dielectric qualities and maximum resistance to heat.
2. **Stator slots insulated with mica-coated fabric**—highly resistant to water, oil, heat and electrical strain.
3. **Dynamically-balanced rotors** to eliminate vibration . . . a practically indestructible unit of pure copper or aluminum passing through rotor laminations.
4. **U. S. standard interchangeable ball bearings** in metric sizes. Mountings protected against dirt and moisture.
5. **Precision-ground shaft**—painstakingly ground to the highest, most exacting standards. Made of the finest, high tensile steel.
6. **All major types**—available from stock . . . open drip-proof, splash-proof, totally enclosed non-ventilated, totally enclosed externally fan-cooled . . . in a wide range of horsepower sizes.

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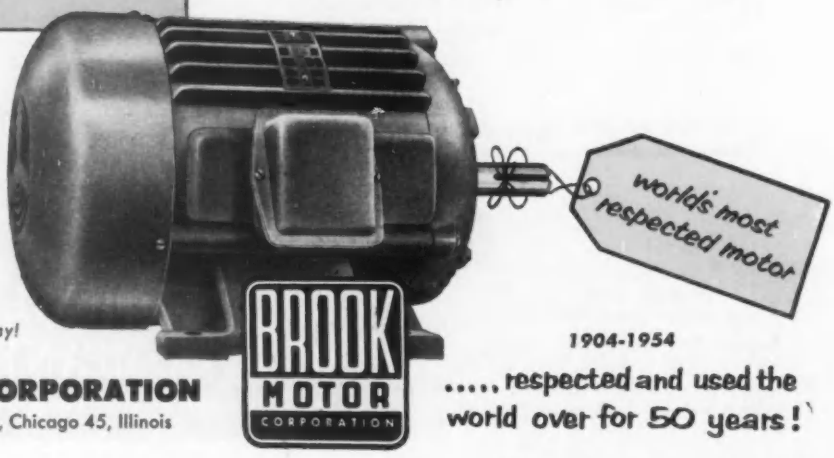
Get all the details about the complete Brook line . . . write today!



world's most respected motor

BROOK MOTOR CORPORATION
3555-57 W. Peterson Avenue, Chicago 45, Illinois

1904-1954

....., respected and used the world over for 50 years!

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STEEL PLATE SHAPES
Directly from Blueprints to Close Tolerances
Ready for Quick Finishing or Assembly
Get Maximum Return on Capital Investment and Plate Inventories
BY-PRODUCTS STEEL CO.
LUKENS

PLATE THAT'S SHAPED TO SAVE YOU MONEY

YOU SAVE both time and money using this new Steel Plate Shapes Service. Find out how you can start production several steps ahead. You can eliminate plate inventories, and you pay freight only on that part of the plate that is actually required.

There's no need to invest in new cutting and forming equipment for your own shops. We have over 150 major machines to flame-cut, shear, blank, press, bend or otherwise form steel plate.

This new Bulletin 712 shows how Steel Plate Shapes Service can help you. For a free copy, use this coupon or write on your company letterhead.

LUKENS

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A DIVISION OF LUKENS STEEL COMPANY

BY-PRODUCTS STEEL CO.
Division of Lukens Steel Company
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Please send me a free copy of Bulletin 712.

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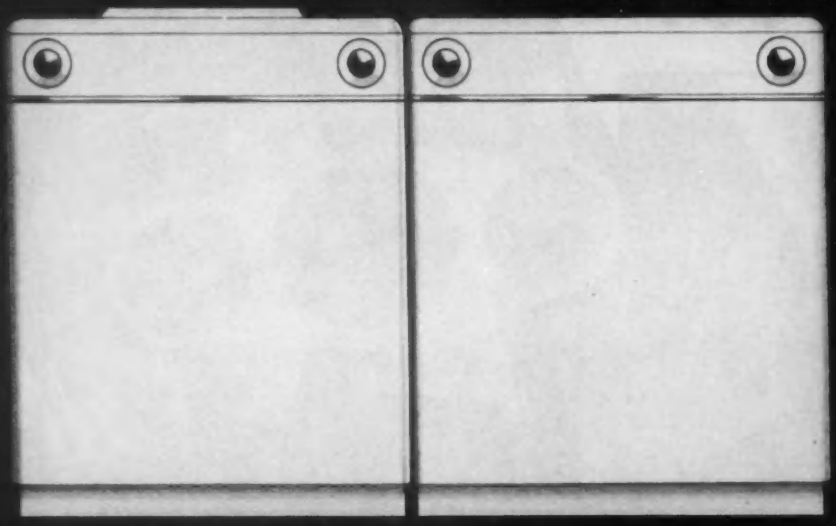
Porcelain enamel can help you sell more!

WASHERS | DRYERS



Lifetime beauty can be a real selling feature . . . especially in a competitive market and with such appliances as laundry equipment.

And it costs but little more to put it into your products, to give users *all* the advantages of ageless *Porcelain enamel.* Not only is Porcelain enamel immune to wear, stains and scratches, but it offers the ultimate in ease of cleaning—all strong selling points with the women who buy this equipment.

If you haven't already gone to Porcelain for the vital "insides" of your products, we would recommend you look into this, also. Again, relative costs may surprise you . . . and here, too, Porcelain enamel can help you build extra sales.

Designers will do well to consider Porcelain enamel in their plans for "best sellers". While there is nothing difficult about it, you do have to *plan* for Porcelain enamel. Can we help you with these plans?

PORCELAIN ENAMEL belongs in your PRODUCT-PLANNING

Only Porcelain enamel, the *fused-in* finish, gives you all these advantages:

1. Permanent, handsome appearance
2. Rust and corrosion resistance
3. High alkali and acid resistance
4. Easy cleaning and low maintenance
5. Long wearing, tough, durable
6. High heat resistance
7. Wide consumer acceptance

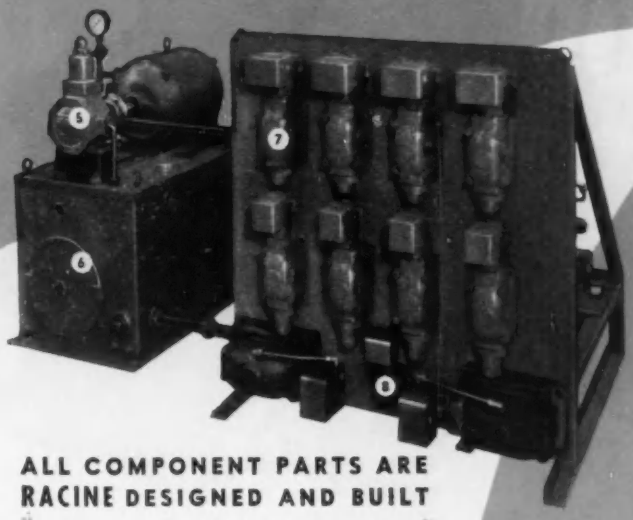
FERRO

FERRO CORPORATION

Porcelain Enamel Division

4150 EAST 56TH STREET • CLEVELAND 5, OHIO

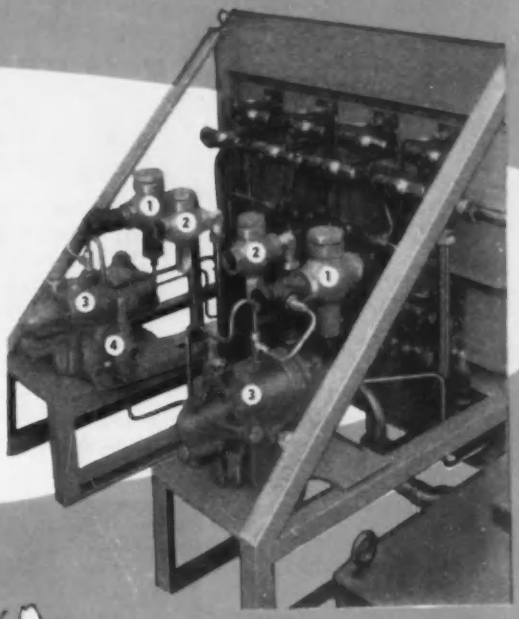
A Compact Hydraulic **POWER HOUSE**
one of many built by Racine for you . . .



ALL COMPONENT PARTS ARE
RACINE DESIGNED AND BUILT
"They work better together"

RACINE
Variable Volume
OIL HYDRAULIC PUMPS

1. RACINE Pilot Operated Check Valves
2. RACINE Free Flow and Throttling Check Valves
3. RACINE Pressure Boosters
4. RACINE Sequence Valve
5. RACINE Variable Volume Pump
6. RACINE Oil Reservoir
7. RACINE Solenoid Controlled, Pilot Operated 4-way Valve
8. RACINE Solenoid Operated 2-way Valve

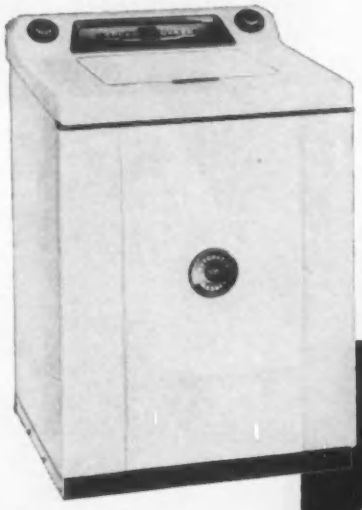


SALES AND SERVICE REPRESENTATIVES
IN ALL PRINCIPAL CITIES.

Racine Hydraulic Components Simplify any Hydraulic Circuit — "They Work Better Together." Write for complete Racine Hydraulic Catalog and the name of your nearest Racine Field Office. Complete Engineering Service Available. Address: **RACINE HYDRAULICS & MACHINERY, INC.,** 2072 Albert St., Racine, Wisconsin, U.S.A.

Mr. Robert M. Cornwall (left), Purchasing Director of Speed Queen Corporation, discusses solenoid and valve coil prices with Mr. A. L. Mahone, Soreng engineer.

how SPEED QUEEN gets what "Engineering" wants– for what "Purchasing" can pay



Speed Queen Model A-12 Automatic Washer

Mr. Cornwall, like most purchasing men, is continually astride the gap between Engineering's "special", "custom" specifications and the never-ending drive for lower costs. He has discovered that Soreng Components—solenoids, switches, etc.—usually bridge the gap. Because—Soreng electrical components deliver custom designed features at mass production prices.

Maximum savings are possible when Soreng is called in at the earliest developmental stage. So, to help lower costs on your advance design, write or call for a consultation with a Soreng Engineer at your plant. No obligation, of course.

SEND FOR new Soreng Data Folder Contains products, technical data, drawings.

SORENG PRODUCTS CORPORATION

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CUTTERS · BROACHES · SPECIAL TOOLS

...to help you engineer the gears you need

BRAD FOOTE GEAR WORKS, INC.
CICERO 50, ILLINOIS

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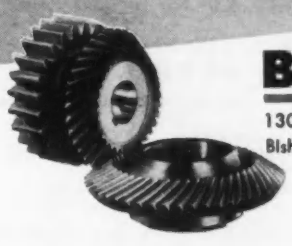
Here's the Way You Can Save Money on Gears

During the many years BRAD FOOTE has been making gears, we have accumulated a large variety of hobs, cutters, and broaches which we have used to make thousands upon thousands of gears to order. With this stock of tools, we are able to do just about any gear cutting job you may have.

By laying out your gears to be made with these tools, you can get what you need quicker . . . and cheaper

Write today on your company letterhead for a free copy of this big catalog which shows all the important specifications needed by gear designers. You'll find it convenient to use, and it will save you money on the gears you buy.

IMPORTANT NOTE: *If you now make your own gears, ask for a copy anyway. You may find that it is cheaper for us to make them.*



BRAD FOOTE GEAR WORKS, INC.

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Bishop 2-1070 • OLympic 2-7700 • TWX: CIC-2856-U

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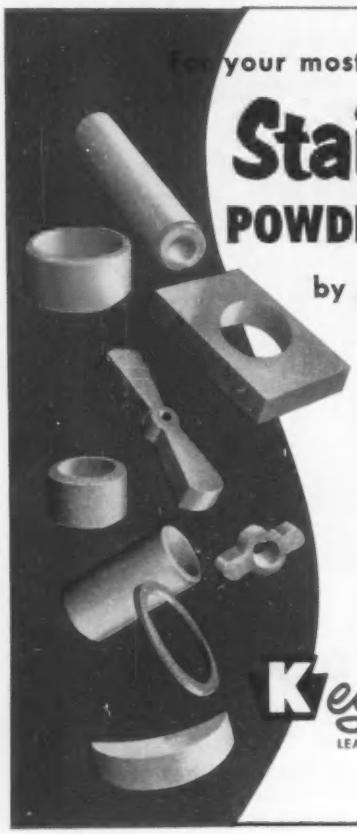
What one fabric out-performs all others!

Obviously, the fabric with versatility. Masslinn *non-woven fabric* is soft and absorbent... can be coated or flocked; processed and finished; made flame and water resistant. Masslinn has unlimited possibilities—can be custom made to suit your requirements.

Meet **Masslinn**®

non-woven fabric

CHICOPEE MILLS, Inc., Dept. PW, 47 Worth Street, New York 13, New York



For your most exacting requirements—

Stainless Steel POWDERED METAL PARTS

by Keystone

Bright, strong stainless steel powdered metal parts are now available from KEYSTONE in large volume for corrosion- and heat-resistant applications, and where appearance is important. Rapid tooling and elimination of machining cut costs. Close tolerances and fine finish make better products. Write for free Bulletin. Send drawing for quotation.

COMPOSITIONS Production grades are types 302B and 316. These are 18-8 chromium-nickel austenitic materials. Other standard and special stainless steel compositions also available.

Keystone CARBON COMPANY

LEADING IN POWDER METALLURGY SINCE 1927

ST. MARYS, PA.

ENGINEERING for PRODUCTION

We have need at Hughes for an engineer broadly qualified in design for production.

This man will direct the *engineering for production* of major precision electromechanical components for missile guidance and control systems. Advanced gyroscopic, hydraulic, and electronic components, already proved fundamentally, must be optimized for weight reduction, manufacturability, and reliability.

Qualifications must include adequate fundamental training followed by wide experience in bringing small precision electromechanical devices to the production stage.

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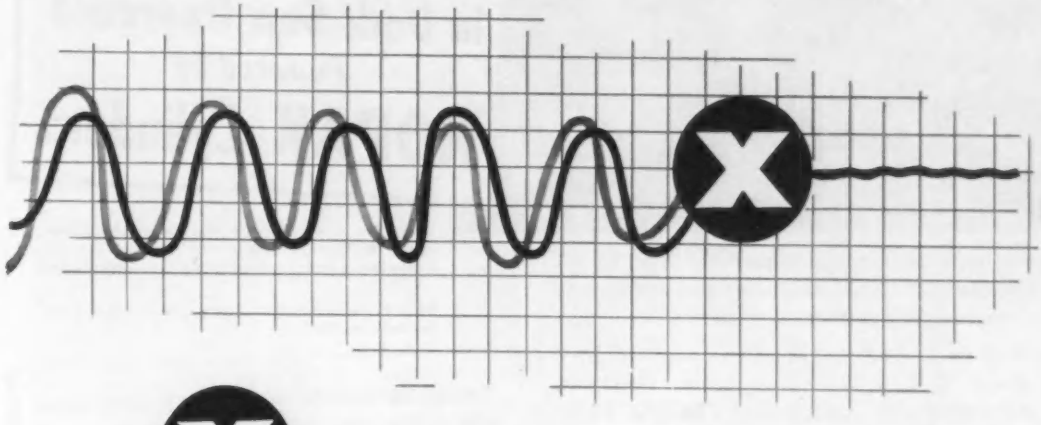
Culver City, Los Angeles County, California

Assurance is required that relocation of the applicant will not cause disruption of an urgent military project.

To CUSHION SHOCK



X IS WHERE WE CAN STOP YOUR GALLOPING ENERGY

If your design—your product—or your project—is endangered by vibration or uncontrolled impact, we can adapt our principle of oil-air shock absorbing to remove the unwanted force.

Whether you want to control the accelerating effect of multiple bounces which begin to coincide; or the landing of tons at high velocity; or continuous vibration—this is the realm for our impact-absorbing engineers.

The principle is applied now in every American aircraft landing gear. It has made Cleveland Pneumatic the world's largest manufacturer of aircraft shock absorbers.

Size doesn't matter. We can engineer shock absorbing, ton-size or pound-size, stopped to *precise industrial tolerances.*

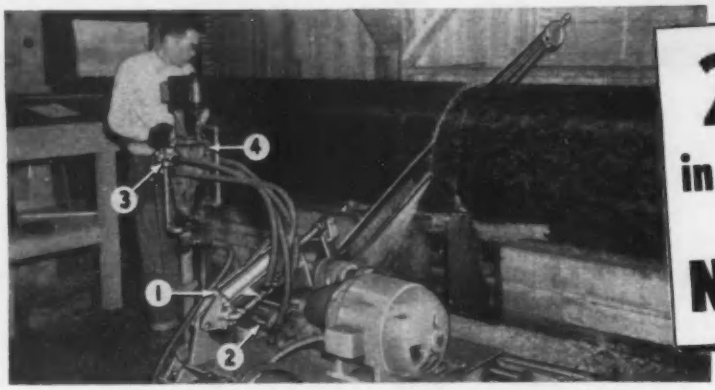
Our free booklet gives enough description of our equipment and applications to show why we have become the world's largest engineers of this principle. Write for it.

CLEVELAND PNEUMATIC
TOOL COMPANY
DEPT. E-54 • CLEVELAND 5, OHIO
BALL-SCREW ACTUATORS AIR-OIL SHOCK ABSORBERS
AUTOMOTIVE SHOP EQUIPMENT

To MOVE with less EFFORT

Combining the screw with balls enables Cleveland Pneumatic's patented ball-screw actuator to drive with as little as 10% friction . . . compared to as much as 50% for ordinary screw drives. You can cut the weight of a drive system, reduce its space, lessen its cumbersomeness, increase its control accuracy and provide metal-to-metal positioning. Work out your ideas with our engineers.

WORLD'S LARGEST MANUFACTURER OF AIRCRAFT LANDING GEARS



2 Vital Movements in Deck Saw Operation *Powered by* NOPAK Cylinders

Arrow No. 1 — NOPAK 6″x14″ Model E Cylinder
Arrow No. 2 — NOPAK 4″x10″ Model E Cylinder
Arrow No. 3 and No. 4—NOPAK ½″ 4-Way Valve

•

Refer to Sweet's File for Product Designers or write for Bulletin SW-2.

This carriage-type deck saw, designed and built by Elk Lumber Co. Medford, Ore., eliminates mis-cutting, and short logs reaching the carriage.

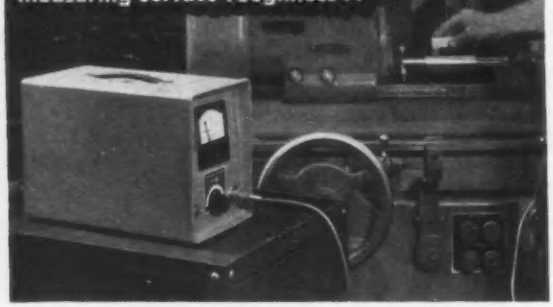
The 8 foot chain-saw bar is raised and lowered by a NOPAK Model E, 6″ x 14″ Air Cylinder. Horizontal carriage movement of 10″, powered by a NOPAK 4″x10″ Air Cylinder, permits operator to locate saw accurately to cut logs within minimum tolerance of ½″. Both movements are controlled by NOPAK valves mounted at operator's station.

This is typical of hundreds of machine movements in which NOPAK Cylinders and Valves are used in all types of industry. For others, see the NOPAK Application Manual.

GALLAND-HENNING NOPAK DIVISION
2762 S. 31st STREET • MILWAUKEE 46, WISCONSIN

NOPAK
VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE
Representatives in Principal Cities

SHOP TOOL for measuring surface roughness . .



The PROFILOMETER

The Profilometer measures the roughness of practically ALL surfaces, internal and external, in micro-inches (arithmetical or r.m.s. average). It's rugged, portable, and simple to use; no experience needed. Used in thousands of production departments — *at the machines.* Sold and serviced by *specialists* in surface measurement . . . since 1936.

FREE BULLETIN LT89 gives details; shows typical applications. Write!

Profilometer is a registered trade mark.

MC Co MICROMETRICAL MANUFACTURING COMPANY
345 S. MAIN ST., ANN ARBOR 6, MICH.

Dress up your product **Assure tight assemblies**

—and get

BIG SAVINGS *with*

PALNUT Trademark
ACORN
LOCK NUTS

- Cost much less than ordinary acorn or cap nuts.
- Spring steel locking action holds tight under vibration.
- Pleasing appearance—covers rough bolt ends.
- Protects users against scratches and catching.

SAVE MONEY and get a secure, streamlined fastening on light assemblies, by using low-cost PALNUT Acorn Lock Nuts. Double-locking spring action resists severest vibration. Easily, speedily applied with hand or power tools. Also used on top of ordinary nuts to cover bolt ends and lock heavy assemblies.

Full range of popular thread sizes, in cadmium, nickel, chrome or other finishes to order.

Send for literature and free samples, stating size and finish.

The Palnut Co., 65 Cordier St., Irvington 11, N. J.
In Canada: P. L. Robertson Mfg. Co., Ltd., Milton, Ontario

Simplify Your Production Methods

with Thiokol® Liquid Polymer LP-2

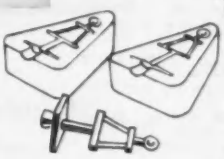
A pourable liquid that converts to a rubber at room temperature WITHOUT SHRINKAGE

Thiokol LP-2 is now used successfully in many critical applications.

PERMANENT FLEXIBLE SEALS

that form tough, resilient bonds with glass, metal, plastics, synthetic rubber, wood and leather.

Sealer made by Minnesota Mining and Manufacturing Company, Detroit, Michigan.



COLD CASTING COMPOUNDS

that conform to exact dimensional shapes of intricate molds and cavities.

Cold casting compound made by Perma-Flex® Mold Company, Columbus, Ohio.

OIL AND SOLVENT SEALS

that seal joints in aircraft wings and other tanks for fuel and solvent retention.

"Thiokol" LP-2 compounds can easily be flowed into place by pouring or by pressure-feed. They cure to elastomers with the following properties:

TOUGHNESS AND RESILIENCE • HIGH BOND STRENGTH
OIL AND SOLVENT RESISTANCE • MOISTURE AND GAS IMPERMEABILITY
BROAD SERVICE TEMPERATURE RANGE • OZONE, SUNLIGHT AND AGING RESISTANCE
DIMENSIONAL STABILITY

The properties of "Thiokol" LP-2, both as a liquid and as an elastomer, simplify production methods and yield desirable product characteristics in the applications illustrated here. "Thiokol" LP-2 may yield similar advantages in your product or process. Our technical staff will gladly discuss the suitability of "Thiokol" LP-2 for any application you have in mind.

Thiokol Chemical Corporation supplies LP-2 only as a raw material. Because of its desirable properties, it was selected as the elastomer for the applications pictured here.

For complete information, write to: Thiokol® Chemical Corporation

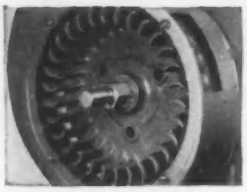
784 NORTH CLINTON AVENUE • TRENTON 7, NEW JERSEY

In Canada: Naugatuck Chemicals Division, Dominion Rubber Company, Elmira, Ontario

WISCONSIN HEAVY-DUTY Air-Cooled ENGINE

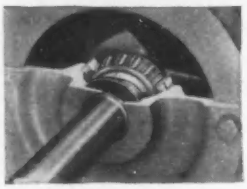
Performance Features

WISCONSIN Heavy-Duty engineering design and construction provide the dependable "Lugging Power" that enables these engines to outperform high-speed power units. When variable or "shock loads" occur, WISCONSIN Lugging Power *hangs on*, where engines of light-duty, high-speed design will stall. *Your Wisconsin Engine keeps the machine going.*



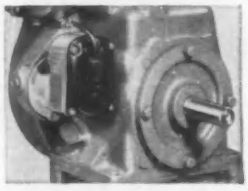
TROUBLE-FREE, ALL WEATHER AIR-COOLING . . .

No machine is any better than the Power that drives it. And efficient cooling, under all operating conditions, is one of the first essentials to *dependable power!* A large capacity fan, cast in the flywheel of every Wisconsin Engine, provides trouble-free cooling, even in the most extreme temperatures.



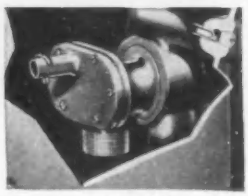
TAPERED ROLLER BEARINGS AT *BOTH ENDS* OF CRANKSHAFT . . .

These self-cleaning, file-hard bearings take up all load thrusts, permitting the use of either chain-, belt- or gear-drive direct from the extended crankshaft, without fear of damaging main or connecting rod bearings. This does away with the need for an outboard bearing.



HIGH TENSION, ROTARY TYPE OUTSIDE MAGNETO . . .

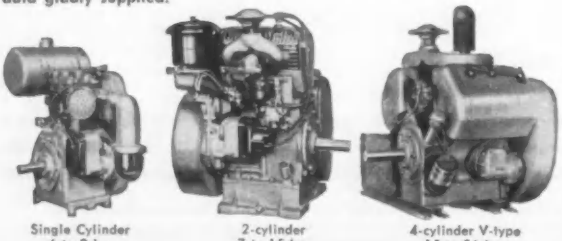
Positive gear drive direct from camshaft assures steady, uniform ignition at all times. The complete unit is conveniently mounted on the OUTSIDE of the engine for easy accessibility. Weather-sealed against moisture and dust. Equipped with Impulse Coupling for quicker, easier starting at all seasons.



POSITIVE, PUMP-CIRCULATED LUBRICATION . . .

All single cylinder models (with exception of Model AEN) have pump-circulated level splash system. Model AEN and multi-cylinder models pump an individual oil stream to each connecting rod. Other parts are lubricated by oil spray, assuring complete and thorough lubrication for smooth-running and long engine life.

These are some of the reasons why it pays to specify "WISCONSIN ENGINE POWER" for your equipment. Engineering and descriptive data gladly supplied.



Single Cylinder 6 to 9 hp. | 2-cylinder 7 to 15 hp. | 4-cylinder V-type 15 to 36 hp.

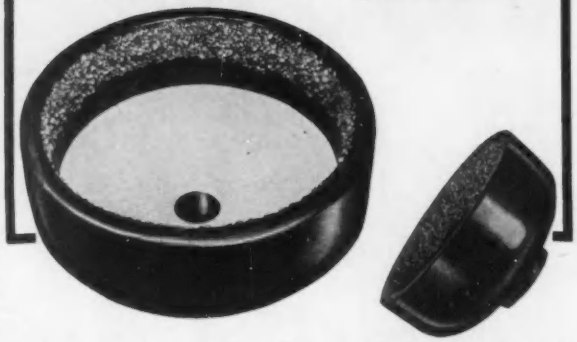
WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

A 7860-½AA

AN INSULATOR THAT PROVIDES A *GRIP!*



Made to customers specifications, this insulator has a sand lining fused to the inside to provide a strong, non-separating grip when it is cemented to a component part. The outside is finished in brown glaze.

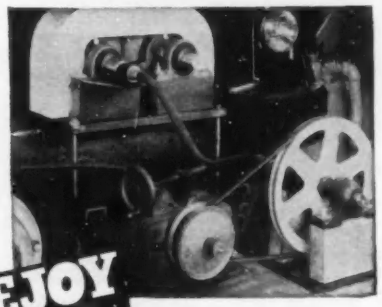
Universal Porcelain Insulators are made to close dimensional tolerances, have uniform body density. They are high in physical and dielectric strength . . . withstand hot electrical arcing, thermal shock, vibration. They resist chemicals, moisture, fumes, heat and cold. And these characteristics remain unchanged during the life of the electrical unit in which they are used. Gain the advantage of Universal Porcelain on your next job! Our engineers are at your service.

THE UNIVERSAL CLAY PRODUCTS CO.

1545 EAST FIRST STREET — SANDUSKY, OHIO

TRADE MARK

the right speed always to FIT THE JOB!



LOVEJOY SELECT-O-SPEED *Variable Speed Transmissions*

Here a Select-O-Speed Transmission is used to drive and control the speed of a pulley and flexible shaft connected to a vibrator that checks vibration of vehicular components at changing speeds.

Make accurate speed adjustments on all types of machinery, new or old, for: *testing—operator ability—variously sized parts or stock—material differences—any other operational variables* . . . without loss of time or labor.

Easily installed, Lovejoy Select-O-Speed Transmission provide better, more efficient production control to help you improve the quality of your products.

Speed ratios to 10 to 1. Sizes to 5 hp. Hand lever or wheel control. Operate with standard V-Belt drives. Fully enclosed.

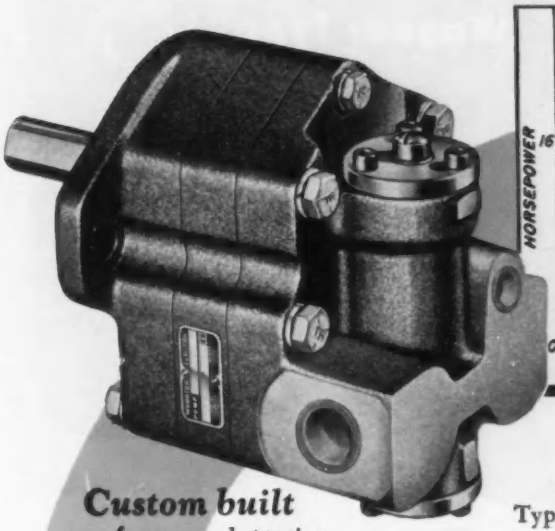
Send today for illustrated catalog giving complete information.

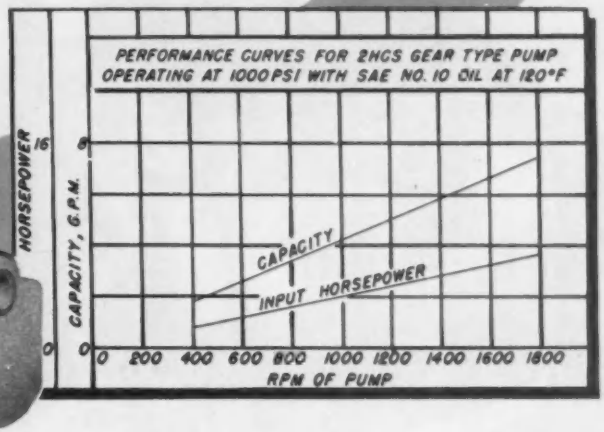
LOVEJOY FLEXIBLE COUPLING CO.

4873 W. Lake Street, Chicago 44, Illinois

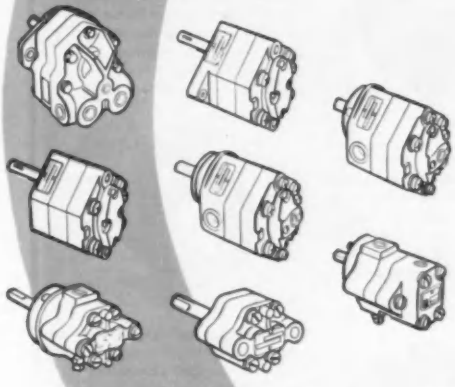
Also Mfrs. of Flexible Couplings, Universal Joints & Variable Speed Pulleys

Check this typical **WEBSTER** Hydraulic Pump Performance Curve





Custom built *for easy adaptation to your system*

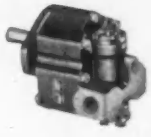


• It will pay you to get the facts about WEBSTER Gear-Type Hydraulic Pumps before buying any pump. Here is a complete line of rugged, dependable pumps from 10 gph. to 10 gpm., engineered to operate efficiently at pressures up to 1200 psi. at speeds of 3600 rpm. or less—90 types of WEBSTER Oil Hydraulic Pumps of various designs and capacities to meet the widest range of requirements!

• WEBSTER pumps are the product of skill acquired during nearly a quarter-century of experience. They have established an enviable reputation for efficient, dependable operation. All WEBSTER pumps lend themselves readily to many forms of adaptation—and to modification for special installations. All are available with built-in relief valve, if desired.

• Whenever you require pumps for lubricating, oil circulating, filtering, transfer or quiet hydraulic power applications, we invite your inquiries.

Write *today for catalog containing performance charts and pump data sheets on which you can describe your requirements*



OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC

RACINE, WISCONSIN

ESTABLISHED 1909

"Where Quality is a Responsibility and Fair Dealing an Obligation"

MANUFACTURERS OF A COMPLETE LINE OF OIL HYDRAULIC PUMPS

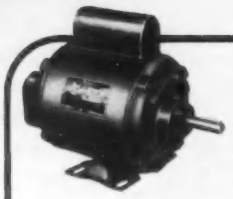
Wagner®
ELECTRIC MOTORS
...the choice of leaders in industry

for single-phase motor applications Wagner Type RK is the Right Kind of motor to use...

Wagner capacitor-start induction motors are the *right kind* of motors to use for most single-phase applications. They have become first choice of many leading manufacturers of air conditioners, refrigerators, freezers, water pumps, and motor-driven tools, and are used in many other similar fractional or integral horsepower applications.

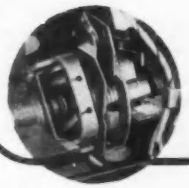
These motors offer low maintenance cost—only a minimum of servicing is required—and they give many years of reliable service with unusual freedom from vibration and noise.

Pictured above is the Wagner Type RK, resilient-mounted capacitor-start induction motor in the new 56 frame that is used for ⅓, ½ and ¾ hp ratings. Smaller fractional ratings, and integral sizes from 1 through 5 hp, are also available.



Wagner rigid base Type RK motor, in the new 56 frame size. The formed steel base is securely welded to the rolled steel frame to produce a strong, rigid mount that will not get out of alignment.

Frames for these motors are made of thick rolled steel, with machined beads which accurately position the end plates. The frames have no openings, and are treated inside and out to prevent rusting.



These motors are equipped with the Wagner quick-break switch that disconnects the starting winding and capacitor from the line when the motor approaches operating speed. It operates over a million times without trouble.

Wagner Electric Corporation
EST. 1891

WAGNER ELECTRIC CORPORATION
6406 PLYMOUTH AVE., ST. LOUIS 14, MO., U.S.A.

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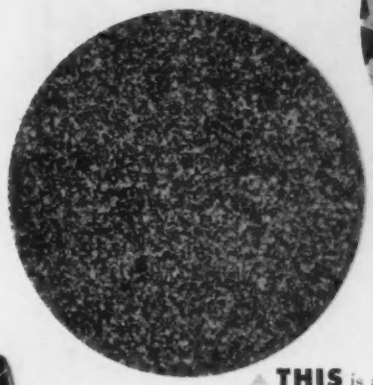
ELECTRIC MOTORS
TRANSFORMERS
INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

M54-15

You don't need 3-D glasses

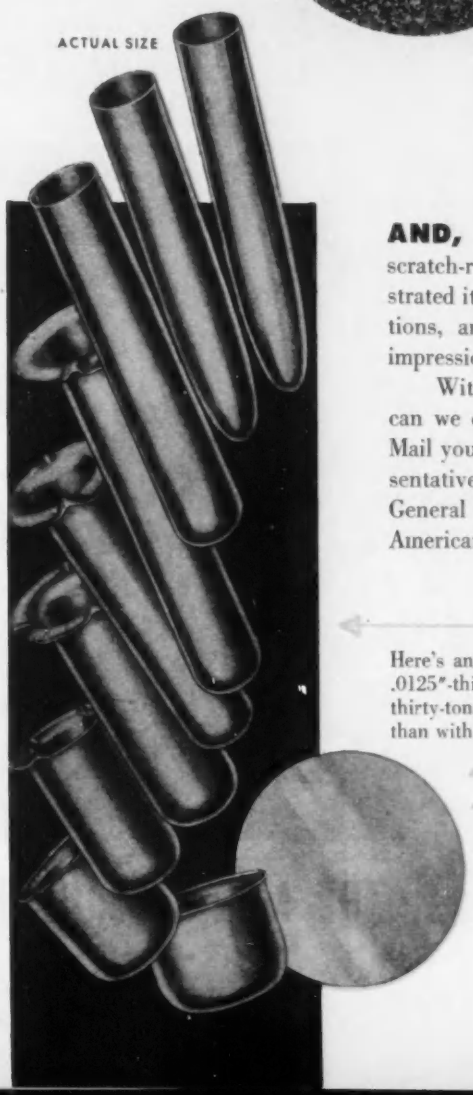
to see the difference

THIS is a 75X magnification of ordinary drawing brass—the kind that's been used for decades for stamped or drawn brass products.



THIS is a 75X magnification of super-fine-grain Formbrite.* Isn't it obvious that this new type of brass can be polished in half the time? Frequently, a simple color buff will bring up the desired finish for lacquering or plating.

ACTUAL SIZE



AND, Formbrite is harder, stronger, springier and more scratch-resistant than ordinary drawing brass, yet has demonstrated its remarkable ductility for forming and drawing operations, and ability to take sharp, clean-cut ornamental die impressions.

With all these advantages, Formbrite costs no more. What can we do to help you try this time and cost-saving metal? Mail you a booklet? Send you a sample? Ask our Sales Representative to call? Simply write to The American Brass Company, General Offices: Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario, Canada.

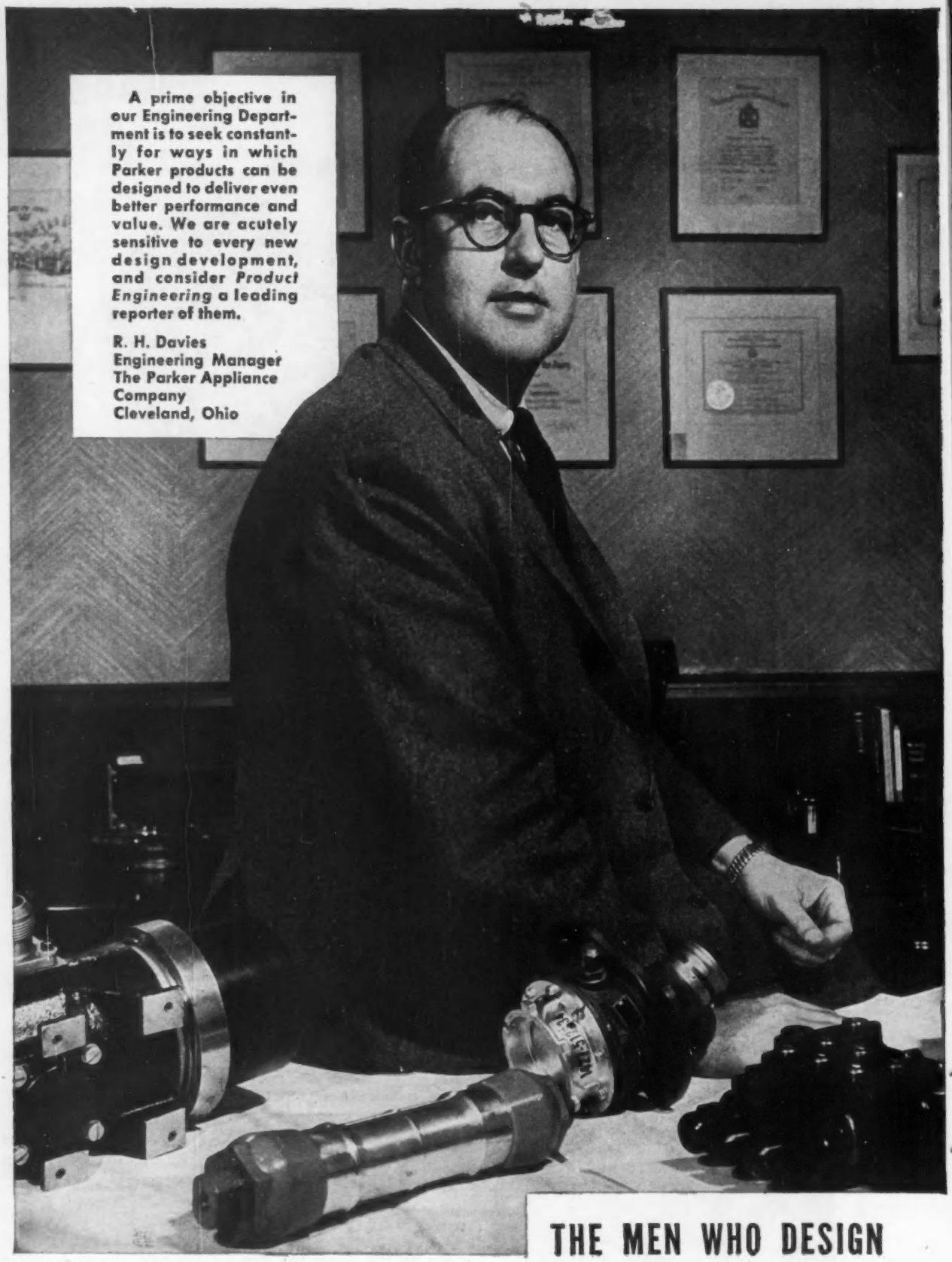
*Reg. U. S. Pat. Off. 5465

Here's an example of Formbrite at work. These pen caps are made of .0125"-thick Red Brass Formbrite strip at the rate of 2,000 an hour on a thirty-ton, 10-step multiple plunger press. Caps are buffed at a higher rate than with any other metal previously used.

Formbrite DRAWING BRASS

an ANACONDA® Product

made by The American Brass Company



A prime objective in our Engineering Department is to seek constantly for ways in which Parker products can be designed to deliver even better performance and value. We are acutely sensitive to every new design development, and consider *Product Engineering* a leading reporter of them.

R. H. Davies
Engineering Manager
The Parker Appliance Company
Cleveland, Ohio

THE MEN WHO DESIGN

He Leads Design at Parker Appliance

HE READS PRODUCT ENGINEERING

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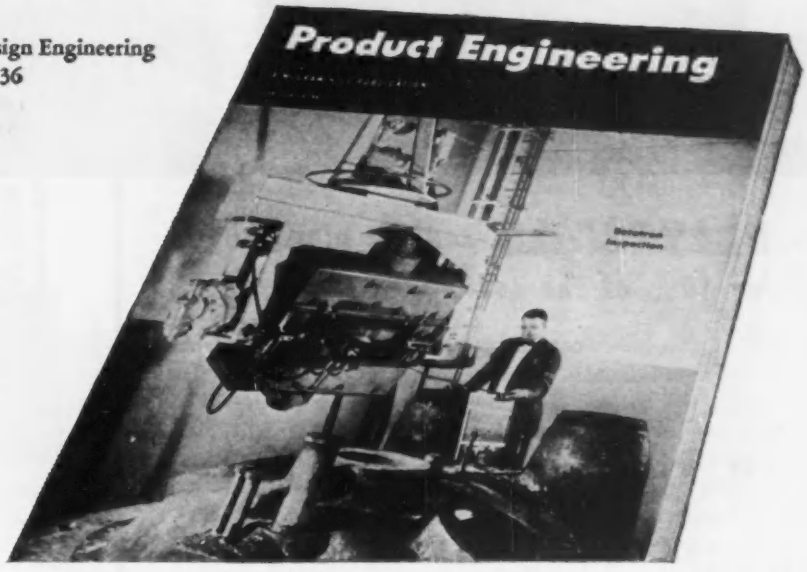
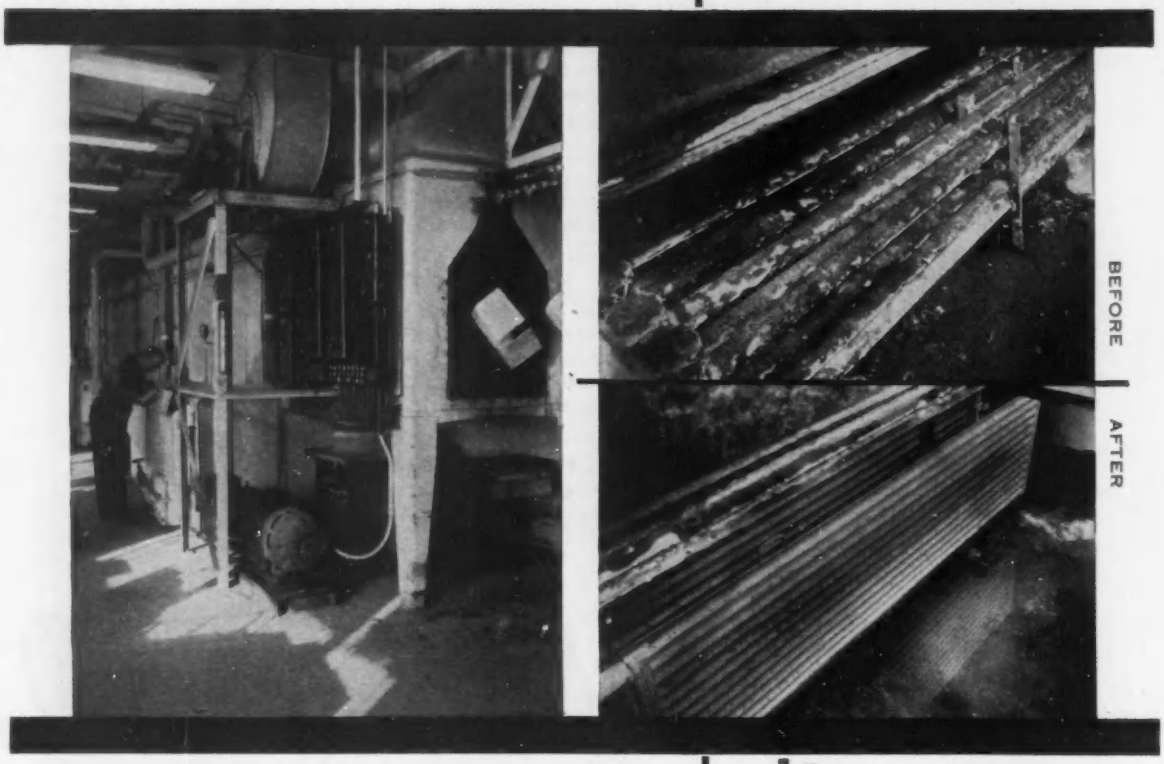


AMERICA'S NEW PRODUCTS READ PRODUCT ENGINEERING

warm-up time reduced 75% as

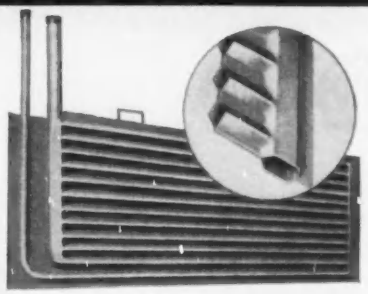
PLATECOILS cure coil-itis*

Burroughs Corporation has reduced warm-up time in their phosphate coating system from 2 hours to 1/2 hour by replacing original pipe coils with Platecoils. They have also saved $1,440 a year in maintenance costs as the pipe coils coated badly and required chipping at least once a month while the Platecoils have required no maintenance in over a year. In addition, the Platecoils cost less to install and take 50% less space in the tank.



PLATECOILS replace pipe coils for 50% of the cost

* Coil-itis is the constant doctoring of wet processing tanks for pipe coil troubles. It can be cured easily by replacing pipe coils with Platecoils. Immediately, you will notice the difference as Platecoils put new life and profits into your heat transfer processes. They heat or cool 50% faster and take 50% less space in the tank. They save as much as 50% in initial cost and 50% in maintenance costs in addition to overcoming the limitations and operating difficulties of old fashioned and outmoded pipe coils.

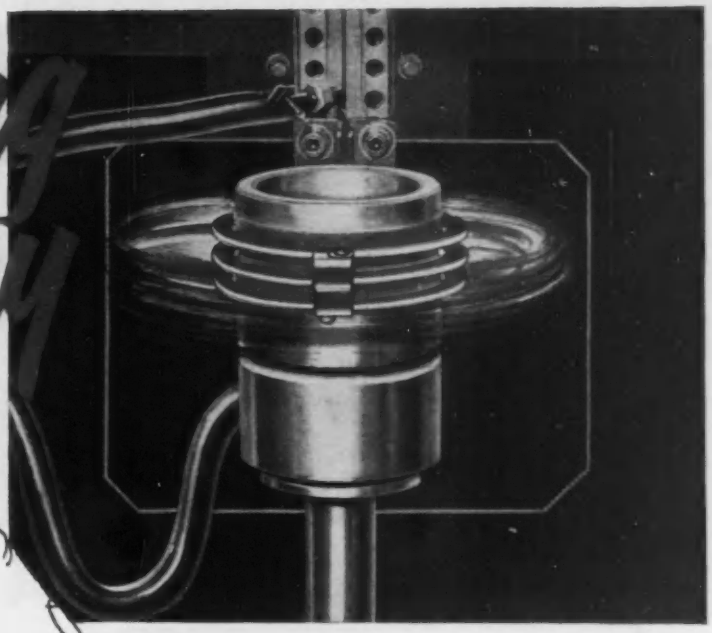


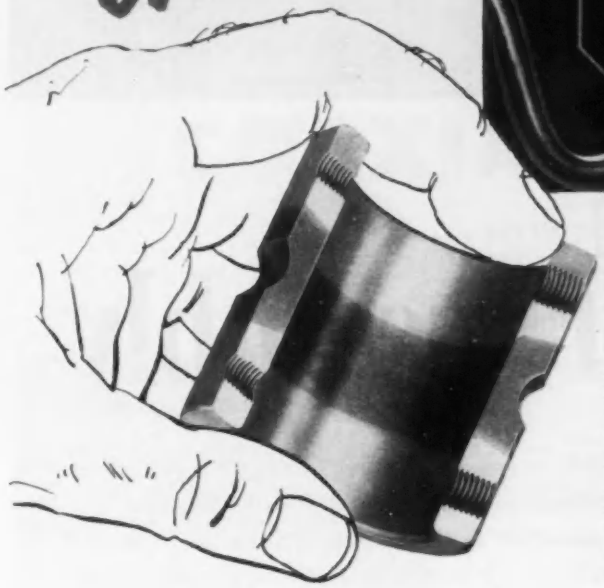
Bulletin P77 shows how Platecoils are replacing pipe coils at a savings throughout industry. Send today for your copy.

Platecoil Division, TRANTER MANUFACTURING, inc., Lansing 4, Michigan

For fast shipment see your local distributor

Blazing the way

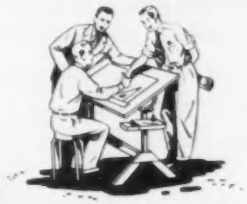




to greater bearing performance!

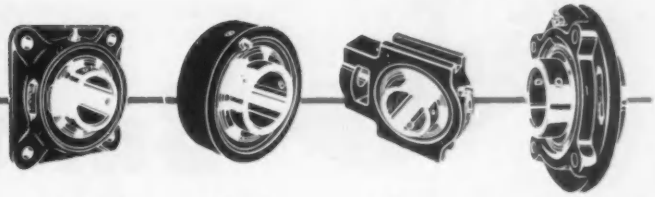
Here's another SEALMASTER patented exclusive in action! *Zone Hardening* is another in a long history of advances that includes: the *first* self-aligning, permanently-sealed industrial ball-bearing unit . . . the *first* outer-race locking pin . . . the *first* ball retainer riding the inner surface of the outer-race ring . . . all patented features! *Zone Hardening* is a completely automatic heat treating process by which the inner-race ring of SEALMASTER Ball Bearing Units are hardened through the ball path and adjacent section only. The extended portion of the inner-race is left in its original metallurgically soft, tough state. Hardened set-screws are mounted through this soft portion of the race, permitting race-to-shaft locking with increased holding power and greater resistance to vibration and shock. Firm lock of bearing to shaft minimizes danger of fretting corrosion and eliminates shaft wear.

This new feature is available on all SEALMASTER Bearing Units which includes a complete line of standard housings, as well as, numerous special designs.



For your copy of Catalog 454 call your SEALMASTER Distributor or write the factory:

SEALMASTER
BALL BEARING UNITS



Flange-Type Unit | Cartridge Unit | Take-Up Unit | Flange-Cartridge Unit

SEALMASTER BEARINGS

A DIVISION OF STEPHENS-ADAMSON MFG. CO.
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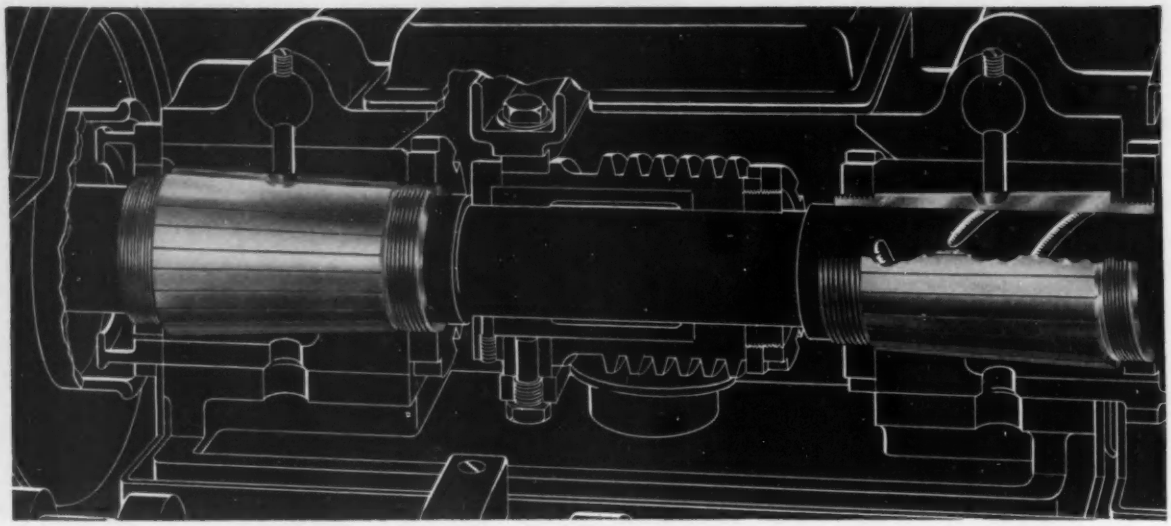

THE WAY TO CUT...

Cost of assembly

The assembly of a unit equipped with sleeve bearings is the simplest, easiest, most understandable assembly possible. After the sleeve bearing has been assembled in the housing or other part that supports it, the shaft which is to operate in it is simply inserted in the bore of the bearing. There is no inboard end cover to assemble on the shaft first, no bearing to be pressed against a shaft shoulder, no lock nut or lock washer to lock the bearing to the shaft, and finally no outside end cover or enclosure to add before the assembly is complete. Not only do these additional parts cost additional money but their preparation for assembly and the actual assembly add serious cost which you can eliminate by using a good cast bronze sleeve bearing design.

There is a Bunting Engineer near you. Consult him. Or write our Product Engineering Department at Toledo.

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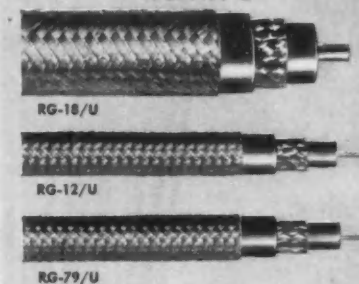

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YOURS FOR THE ASKING: Federal's new 28-page buying guide contains a world of information on Federal quality-controlled wires and cables, plus numerous tables and diagrams. For your free copy write to the department above.

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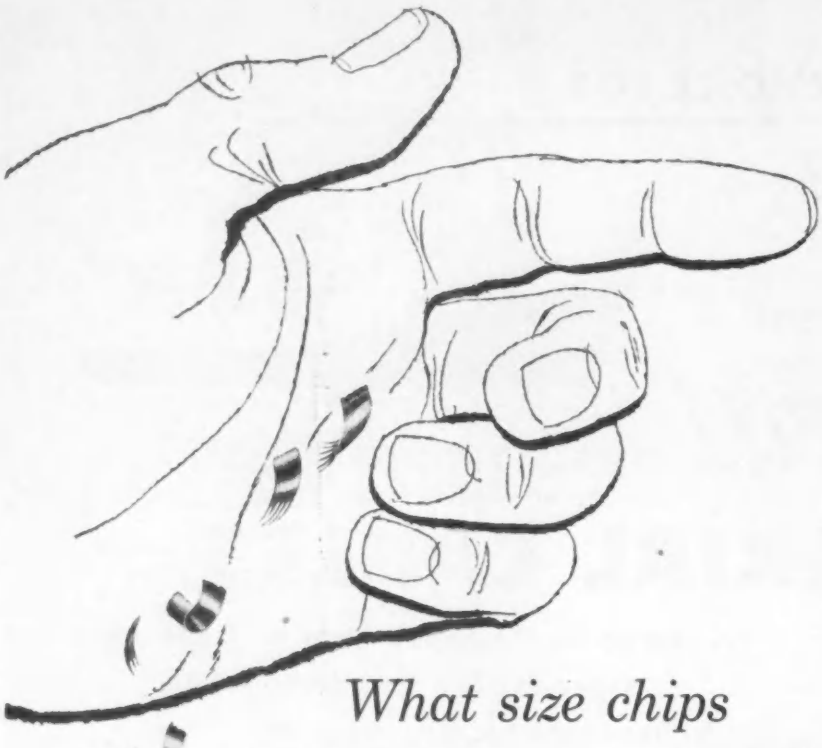

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For easier cutting and clearing, for *longer tool life,* those chips should be *short.* Chase Free-Cutting Brass Rod has just the precise amount of lead to yield these shorter chips. Chase rod means a lower unit cost on your products too — it's cleaner, smoother-surfaced, less expensive to buff or polish before finishing. Available in a wide variety of alloys. Call your nearest Chase Sales Office or Warehouse.

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How Cindus X-CREPE® gives Longer Life

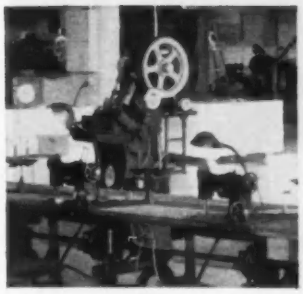
to death-dealing U.S. Fly Swatters

X-Crepe makes clean, firm edge-binding . . .
Replaces expensive felt, leatherette.

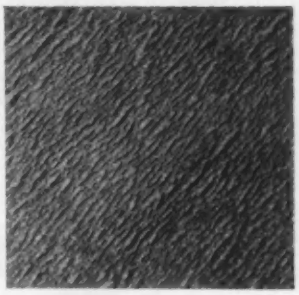
Long life, ability to withstand hard wallops from day to day—are prime requirements in top grade, dependable fly swatters. Whether swatter blade is wire-cloth, fiber or cellophane, *tough, durable edge-binding* is the key to more trouble-free swat mileage.

United States Mfg. Corp., Decatur, Ill., world's largest fly swatter manufacturer, used to bind with expensive felt and leatherette. Disturbing field reports indicated this binding frayed, deteriorated—too soon. Blades would kink. Even experienced wielders got too many "misses" and "probables."

Then E. W. Twitchell Inc., Phila., Pa., binding experts, recommended sturdy, economical X-CREPE for the job. X-CREPE won't crack, is pliable, formable, creasable, sewable, easy to work with—perfect for dependable edge-binding.



In the sewing room, X-CREPE is easier to work with than felt or leatherette. U. S. feeds bright-colored X-CREPE from 5/8" wide rolls into binder. X-CREPE creases readily, won't "drag" through binder, doesn't break thread or slow production. Material goes smoothly onto swatter blade, gets high-speed zig-zag stitch on electric Singer Sewing Machines. Out comes another strong, attractive U.S. Swatter.



X-CREPE is pliable, stretchable, formable. It can be impregnated, coated, laminated—or combined with cloth and fibers, films and foils to extend the use of such materials far beyond their usual limits. It can be used like cloth, instead of rubber, in place of cork, and for jobs where no other material will do. Available in a wide range of basis weights—sheets, rolls, die-cut shapes, bags and liners.

Now, U.S. Fly Swatters, with their colorful X-CREPE binding, stay clean looking, firm, last far longer. Blades stay flat, effective. Beginners and veterans alike swat with confidence. U.S. Fly Swatter sales are up and distraught house flies are taking up outdoor living.

This example is typical of hundreds of cases where manufacturers have standardized on X-CREPE because it fills a wide variety of needs better and more economically than less versatile materials. We can tailor X-CREPE to fit *your* needs.

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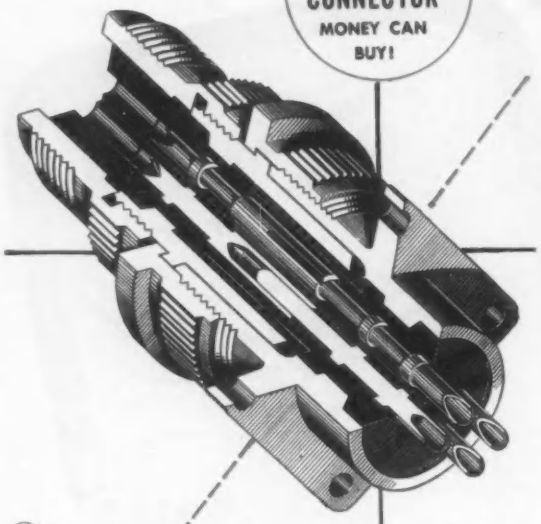
The Finest ELECTRICAL CONNECTOR MONEY CAN BUY!



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IT PERMITS SIMPLICITY

When operating conditions demand an electrical connector that will stand up under the most rugged requirements, always choose Bendix Scinflex Electrical Connectors. The insert material, an exclusive Bendix development, is one of our contributions to the electrical connector industry. The dielectric strength remains well above requirements within the temperature range of −67°F to +275°F. It makes possible a design increasing resistance to flashover and creepage. It withstands maximum conditions of current and voltage without breakdown. But that is only part of the story. It's also the reason why they are vibration-proof and moisture-proof. So, naturally, it pays to specify Bendix Scinflex Connectors and get this extra protection. Our sales department will be glad to furnish complete information on request.

• Moisture-Proof • Radio Quiet • Single Piece Inserts • Vibration-Proof • Light Weight • High Insulation Resistance • High Resistance to Fuels and Oils • Fungus Resistant • Easy Assembly and Disassembly • Fewer Parts than any other Connector • No additional solder required.

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ELECTRICAL CONNECTORS

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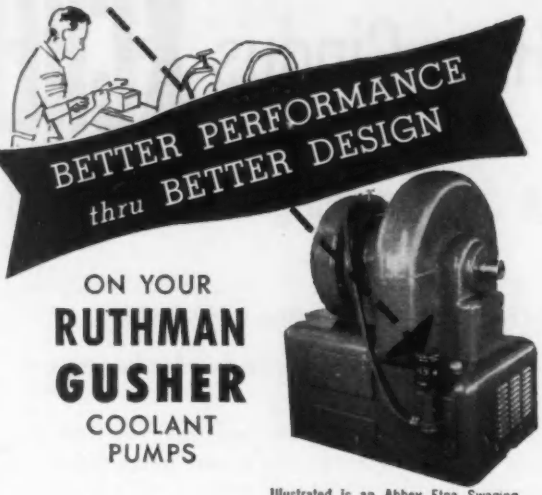

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COOLANT
PUMPS

Illustrated is an Abbey Etna Swaging Machine, Series #154, equipped with a Ruthman Gusher Coolant Pump

All Gusher Coolant Pumps are designed to give you better performance. You get split-second control of coolant flow from the instant the machine is turned on.

Pre-lubricated heavy-duty ball bearings require no further lubrication. There is no packing or priming necessary. The electronically balanced rotating assembly reduces vibration and lengthens the life of your Gusher Coolant Pump. Always specify Gusher Coolant Pumps. Write for catalog.

THE RUTHMAN MACHINERY CO.
1818 Reading Road Cincinnati, Ohio

Space Savers
SPLIT
BALL BEARING
BUSHINGS
. . . giving both radial and thrust capacity

They have solved many design and operation problems. . .
SHEAVES FULCRUMS IDLERS
CAMS OSCILLATING MOTIONS

Shaft rotation at moderate speeds.
Lubricated for extended operation.
Only a quarter inch section height.
For shafts from 7/16" to 1½".

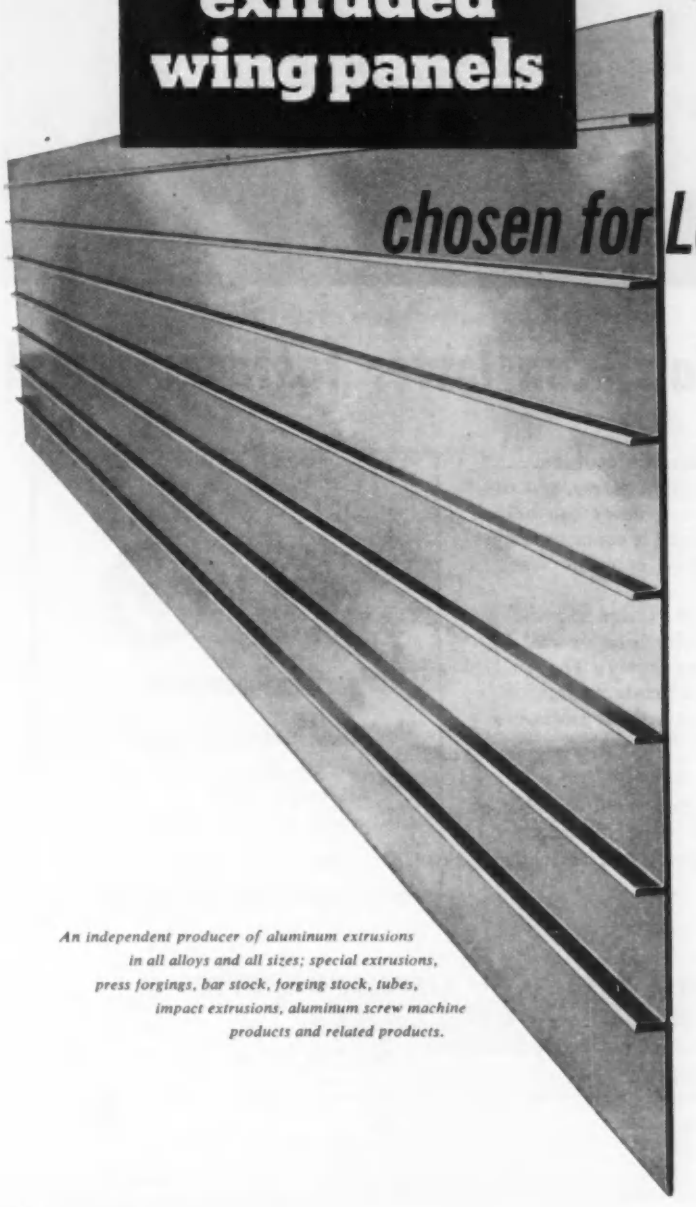
Ask for folder giving sizes and load capacities. Call on our Engineering Department for advise and help on your applications.

SPLIT BALLBEARING CORP.
LEBANON NEW HAMPSHIRE

Lightweight rigidity of

Harvey aluminum extruded wing panels

chosen for Lockheed XFV-1



Progressive aircraft engineering, exemplified by Lockheed's sensational new vertical takeoff fighter plane, means producing for tomorrow's needs today. Progressive aluminum engineering made it possible for Harvey to extrude extra wide, integrally stiffened wing panels for this fighter plane of the future. In addition to their great strength, these extruded aluminum wing panels mean substantial savings in machining and fabricating costs. This example is typical of what can be done with the many advanced extrusion techniques and modern equipment available at Harvey. You'll find it pays to deal with Harvey, the world's largest independent producer of aluminum extrusions.

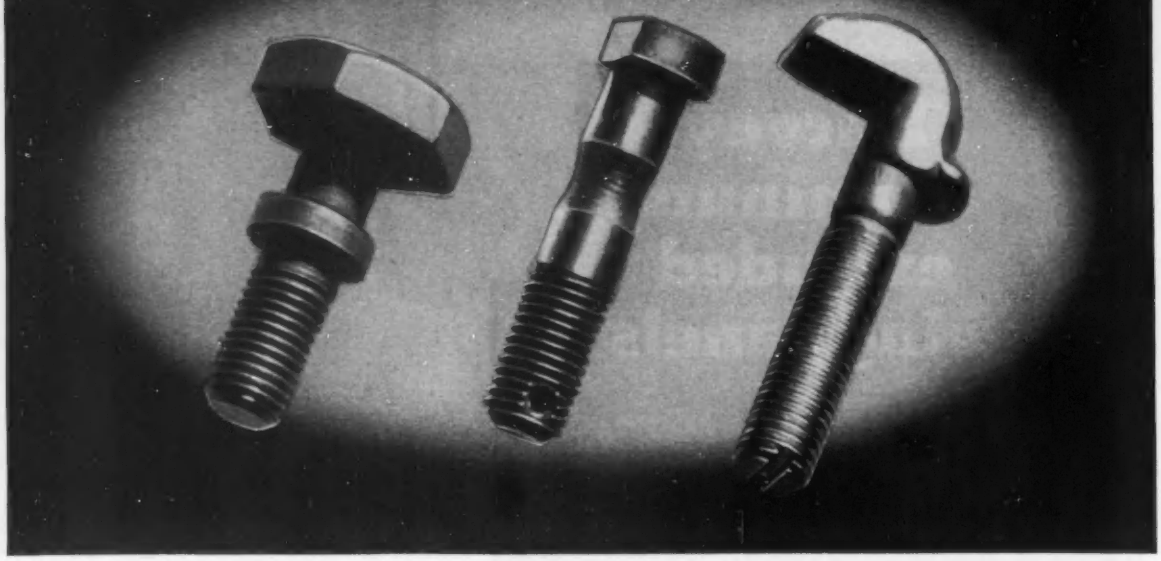
An independent producer of aluminum extrusions in all alloys and all sizes; special extrusions, press forgings, bar stock, forging stock, tubes, impact extrusions, aluminum screw machine products and related products.

MAKING THE MOST OF ALUMINUM . . . FOR EVERYONE

HARVEY Aluminum

HARVEY ALUMINUM SALES, INC.
TORRANCE—LOS ANGELES, CALIFORNIA
BRANCH OFFICES IN PRINCIPAL CITIES

BRING YOUR "SPECIAL" PROBLEMS TO *National*



Cold heading "Specials" can lower fastener costs!

When you have any "special" fastening problem . . . requiring an unusual type of bolt, nut, screw, pin or headed or threaded part . . . our engineers can help you design it . . . and we can produce it economically on our wider range of cold heading equipment and specialized machinery.

For prompt assistance in solving your "Special" problems, just send us your specifications or call in your nearest National representative for full information on National's "Special Products Service" and the most complete line of standard fasteners for industry.

★ ★ ★

Representatives in Chicago, Cincinnati, Detroit, New York, Philadelphia, Kansas City, Milwaukee, Rochester, Denver, St. Louis, San Francisco, or Seattle —write or call direct to:

support Junior Achievement

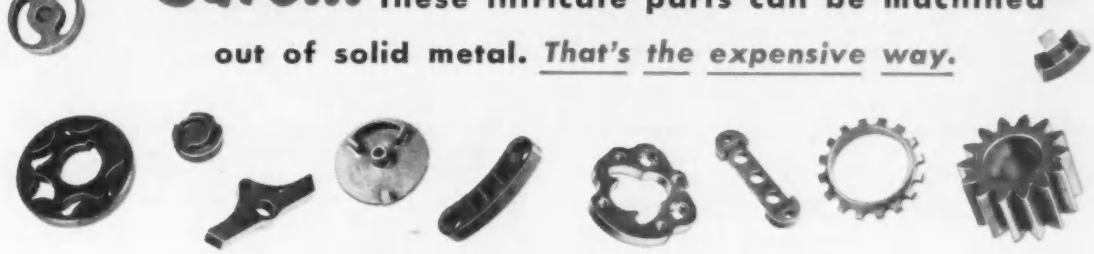
Junior Achievement Week
January 31-
February 6, 1954

THE NATIONAL SCREW & MFG. CO. • CLEVELAND 4, OHIO
Pacific Coast: **National Screw & Mfg. Co. of Cal.**
3423 South Garfield Ave., Los Angeles 22, Cal.

National PRODUCTS — FASTENERS — HODELL CHAINS — CHESTER HOISTS

YOU SAVE WHEN YOU USE OILITE FINISHED MACHINE PARTS

Sure... these intricate parts can be machined out of solid metal. *That's the expensive way.*



But... these FINISHED MACHINE PARTS are being made by OILITE *at a Fraction of the Cost.*

Oilite Finished Machine Parts serve the same purpose as conventional "machined" parts. Their performance is just as good, often better, because they can be self-lubricating and made to closer precision tolerances.

Recent achievements by Oilite Research have materially broadened the scope and application of Oilite — Products of Metal Powders.

AMPLEX
DIVISION OF CHRYSLER CORPORATION
Detroit 31, Michigan, Dept. F-5

6761

Call an Oilite Engineer. Let him develop your ideas. He will suggest ways and means for decreasing your part costs and show you how to attain other important goals.

FIELD ENGINEERS, DEPOTS AND DEALERS THROUGHOUT UNITED STATES AND CANADA

Oilite Products of Metal Powders Include:
BEARINGS, FINISHED MACHINE PARTS, CORED AND SOLID BARS, PERMANENT FILTERS AND SPECIAL UNITS

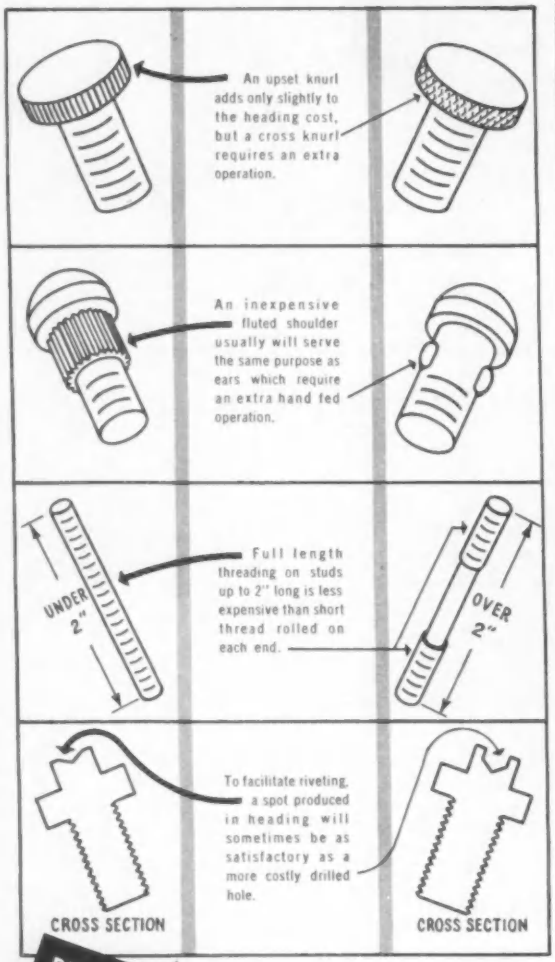
STILL MORE WAYS TO

SQUEEZE PENNIES

OUT OF

UPSET SPECIALS COSTS

Specially designed upset products are solving thousands of problems. Dozens of design pointers on them are yours for the asking. Send us your sketches, prints, finished products for suggestions.


An upset knurl adds only slightly to the heading cost, but a cross knurl requires an extra operation.
An inexpensive fluted shoulder usually will serve the same purpose as ears which require an extra hand fed operation.
UNDER 2"
Full length threading on studs up to 2" long is less expensive than short thread rolled on each end.
OVER 2"
To facilitate riveting, a spot produced in heading will sometimes be as satisfactory as a more costly drilled hole.
CROSS SECTION
CROSS SECTION

REPRINTS of this and of previously published charts are available on request for use in drafting and purchasing departments.

QUALITY PROMCO BRAND

MACHINE SCREWS AND SPECIAL FASTENERS ARE OUR BUSINESS

WRITE FOR OUR CATALOG

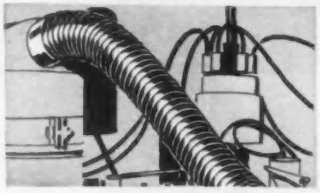
THE PROGRESSIVE MANUFACTURING COMPANY

48 NORWOOD ST. TORRINGTON CONN.

Designers Cut Cost with FLEXAUST*

spiral-wire reinforced hose

SIZES 1¼ in. to 36 in. ID



For { Air Conditioning, Automotive Air Cleaner Ducts, Dust Collection, Electronic Tube Cooling, and other applications in moving air, dust, gases, materials.

Check these *Basic Economies:*

- ✓ **FITS ANY SPACE**—Installs fast without damage, adapts easily to any connecting outlets.
- ✓ **RUGGED MATERIALS**—Double ply, neoprene impregnated cotton or nylon, spiral-wire reinforced.
- ✓ **LOW COST**—Beats metals for bends and turns, supports easily, fits modified standard designs.
- ✓ **HIGHLY FLEXIBLE**—Light weight, compressible, low bending stress, absorbs vibration and sound.

For sizes, coatings, accessories, flow characteristics for your applications . . . write for catalog today.

THE FLEXAUST COMPANY

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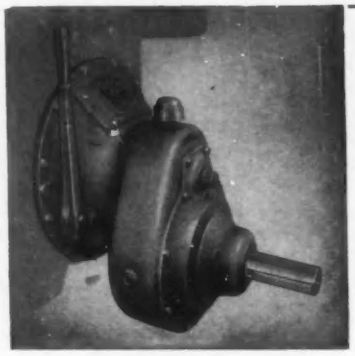
Formerly American Ventilating Hose Co.

FLEXAUST* PORTOVENT* BLOFLEX*

*Trade-marks

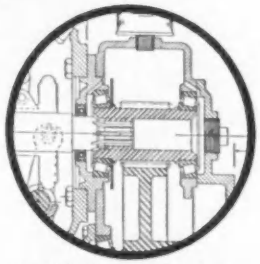


FUNK

GEAR REDUCTION POWER TAKE-OFFS

FOR INDUSTRY AND AGRICULTURE

with the exclusive Straddle Mounted Pinion . . . .

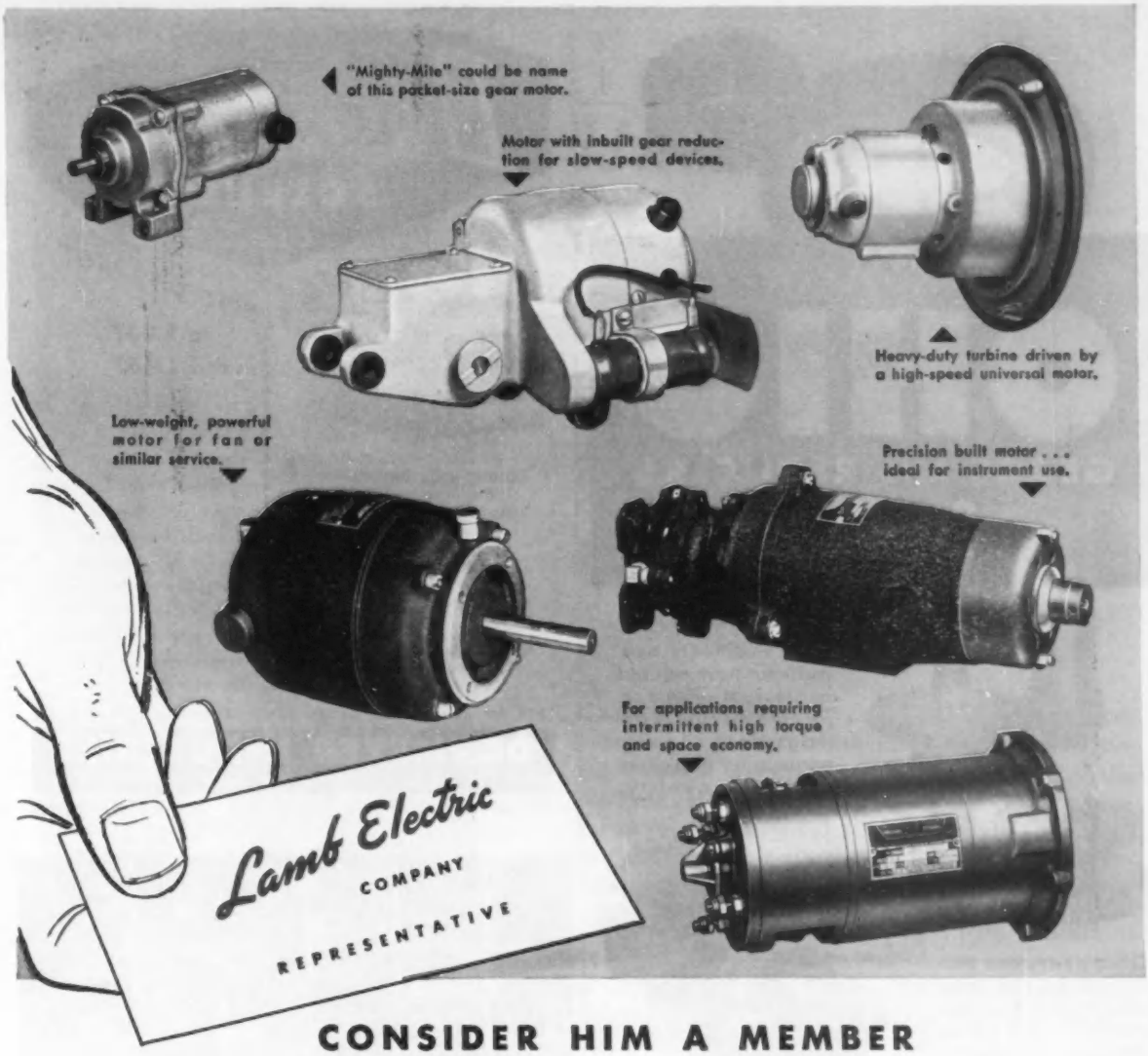


This exclusive Funk development assures complete gear tooth contact at all times by providing a pinion with a taper roller bearing support at each end driven by an input shaft with a lubricated floating spline, eliminating misalignment from improper installation or load deflection . . . . some of the many reasons why you can expect longer, trouble-free service from FUNK Gear Reductions. Fit all SAE flywheel housings. Special ratios or special adaptions of standard units supplied in large or small orders. Write for catalog and specifications of Funk Power Take-Offs and Gear Reductions, or assistance on any special power problem.

Funk F

FUNK AIRCRAFT CO.

3301 Airport Drive Coffeyville, Kan.


"Mighty-Mite" could be name of this pocket-size gear motor.
Motor with inbuilt gear reduction for slow-speed devices.
Heavy-duty turbine driven by a high-speed universal motor.
Low-weight, powerful motor for fan or similar service.
Precision built motor . . . ideal for instrument use.
For applications requiring intermittent high torque and space economy.
Lamb Electric
COMPANY
REPRESENTATIVE

CONSIDER HIM A MEMBER OF YOUR *Engineering Staff . . .*

Many companies are finding it quite helpful to call in the Lamb Electric district engineer for suggestions, when designing a new motor-driven product or redesigning an existing one.

Through close cooperation of the manufacturer's engineering department and Lamb Electric engineers, such advantages as reduced costs, improved appearance, greater compactness and lower weight are often obtained.

The time to realize the full benefit of this teamwork is while your product is still in the blueprint stage.

THE LAMB ELECTRIC COMPANY
KENT, OHIO

In Canada: Lamb Electric — Division of Sangamo Company Ltd. — Leaside, Ontario

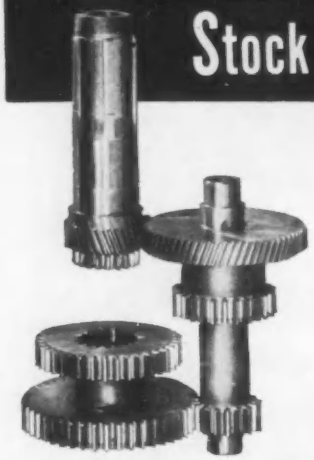
Lamb Electric
SPECIAL APPLICATION
FRACTIONAL HORSEPOWER
MOTORS

THEY'RE POWERING AMERICA'S *First* PRODUCTS

OHIO

GEARS AND REDUCERS

Stock or Special



• For Forty years Ohio Gear engineers and craftsmen have enjoyed an unusual reputation for turning specifications into power transmission of highest industrial quality.

Ohio gears are produced by the most modern equipment and methods in gear cutting. Complete up-to-date machinery operates throughout the plant... cutting, broaching, milling, drilling, heat treating and grinding.

Ohio Gear specializes in Spur, Bevel, Miter, Helical, Worms and Worm Gears, Sprockets, and Spline Shafts.

We will be glad to assist you in your gear production problems and quote on your specifications.

DISTRIBUTORS IN PRINCIPLE INDUSTRIAL AREAS

THE OHIO GEAR COMPANY

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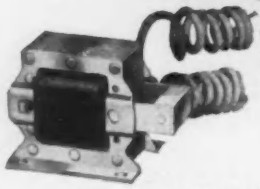
OHIO GEARS

DORMEYER

Machine Tool SOLENOIDS are..

Precision-Built

to LAST and LAST



Endurance is built right into each Dormeyer Solenoid. Performance records show that 17,000,000 or more cycles have no effect on their quiet operation, smooth and trouble-free service.

Constructed from the finest materials available, Dormeyer Solenoids are engineered to specifications to give maximum service in the most difficult industrial service.

Dormeyer Precision-Wound Coils— *Quality controlled and available in quantity through our modern mass production facilities. For every electrical purpose, including fine wire coils up to* No. 50 Wire.

Send for catalog and include specifications for free estimate

DORMEYER INDUSTRIES

FACTORIES IN CHICAGO AND KENTLAND, INDIANA

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Safe Power

Eimco dependable air motors provide safe power for operation in plants working with the most combustible of materials.

They are not damaged by overloads or stalling, nor is there any danger of ignition. Built in three sizes with a range from 7½-20 HP.

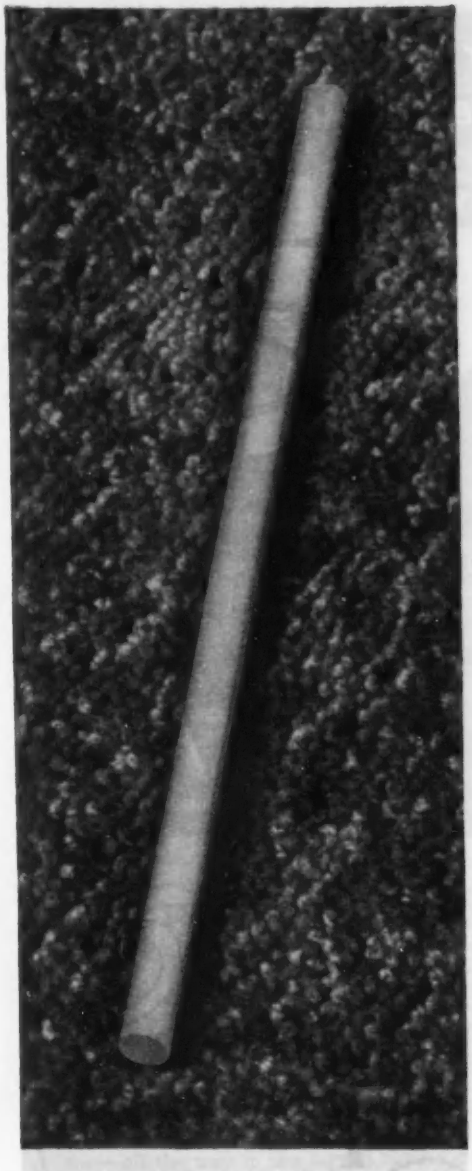
Available with geared reducers in a speed range from 45 to 104 RPM.

B25

THE EIMCO CORPORATION

Salt Lake City, Utah, U.S.A.

Export Office: Eimco Bldg., 52 South St., New York City



Here's good news for your product . . .

TAYLOR POLYESTER GLASS RODS

An unusual material developed by Taylor—polyester glass rods in natural, white, black and ten attractive colors—offers unlimited possibilities in many of the products you manufacture. For the first time, you can have a glass-reinforced plastic that is uniformly colored all the way through. Drill it . . . cut it . . . grind it . . . you'll see no fibrous appearance of glass filaments.

Although this new material weighs only one-fifth as much, it possesses flexural and tensile strength equal to that of low carbon steel. It's non-corrosive, and resists deformation from bending. Picture how you can use its color for decoration, identification, or coding . . . its high strength-to-weight ratio for structural parts . . . its excellent electrical properties in shafts for electronic components.

Taylor specialists will be glad to talk over the ways you can put this material to work. They'll be glad to discuss, too, the improvements in production and product quality that you can realize through the use of Taylor Vulcanized Fibre and Taylor Melamine, Phenolic and Silicone Laminates.

Colors available in production quantities include:

Natural . . . white . . . yellow (two shades) **. . . buff . . . orange . . . pastel red . . . red . . . dark red . . . brown . . . green . . . blue . . . black.**

SPECIFICATIONS: GPG Rod

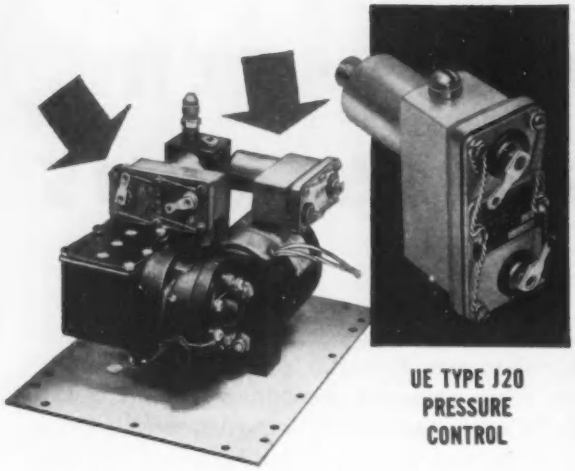
Flexural strength	65,000—85,000 psi.
Compressive strength (radial)	950—1,100 psi.
Arc resistance	120 sec.
Water absorption	0.10—0.20%
Resin content	50%
Specific gravity	1.60
Standard diameter	⅛" to ½"
Standard lengths	24" to 84"

Also available Chalk-Filled (GPG-C) and Flame-Retardant (GPF). Inquiries invited for larger diameters, longer lengths and special shapes.

TAYLOR FIBRE CO.
Norristown, Pa.—La Verne, Calif.

TAYLOR
Laminated Plastics
Vulcanized Fibre

UE PRESSURE CONTROLS MAINTAIN SET PRESSURES IN THE STRATOSPHERE



UE TYPE J20 PRESSURE CONTROL

The electronic equipment in today's high-flying aircraft requires uniform pressure conditions at predetermined levels in order to function accurately. At current operating altitudes, this pressure is supplied by pressurization units made by Eastern Industries, Inc. – and maintained by *UE* Type J20 controls.

The pressurization unit maintains a constant pressure at all times, between predetermined settings, thus assuring reliable performance of the plane's electronic equipment. The *UE* Type J20 Pressure Control automatically cuts the pressurization unit's motor in and out at those predetermined settings – thus assuring optimum electronic performance.

UE Type J20 – now offered commercially for the first time – is also being used in pressurized coaxial cables, R. C. A. ground radar, and in maintaining frequency bands.

United Electric manufactures a wide line of standard controls that are used in aircraft fuel purging systems, paper mill machinery, diesel engines, milk pasteurizers, room air conditioners and in countless other applications.

Special controls can be adapted from standard models, or can be custom built by United engineers working in cooperation with your own product development engineers.

Write today for information on the complete line of United Electric Controls.

Standard and special thermostats and pressure switches

UNITED ELECTRIC CONTROLS CO.

87 School Street, Watertown, Mass.

For precision-made seals use LINEAR "O" RINGS

Available from Linear is a wide variety of high-quality, precision-moulded "O" rings for industrial applications . . . also "O" rings to meet the latest government requirements, such as AN or MS types to MIL-P-5516, MIL-G-5510, MIL-P-5315 requirements.

Write or call for complete information.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR Inc., State Rd. & Levick St., Philadelphia 35, Pa.

Imperial

THE *Finest* TRACING CLOTH

Imperial is known in drafting rooms all over the world as the traditional quality tracing cloth.

With the background of decades of experience, its makers have pioneered in modern improvements to maintain Imperial as the finest tracing cloth made.

Vibration testing made easier

Electronic component under test at Eclipse-Pioneer division of Bendix Aviation Corporation.

with the help of MB equipment like this

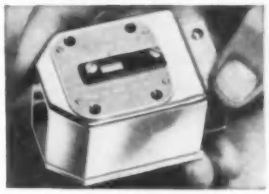
Do you have to vibration-test your product to meet military specifications? Want to apply shake-testing to improve product design or to control quality? If so, do what many leading companies have done—enlist the help of MB.

First, you get the right equipment. MB offers a *complete* line of vibration exciters from 10 pounds force all the way to the largest developed today—10,000 pounds! All are quality built to stand up and do the job right to specifications. Electromagnetic in operation, they're easily and quickly adjusted for force and frequency. And, second, you get the benefit of MB's wide experience in applying this relatively new and valuable technique for product improvement.

Among the well known companies working with MB products, Bendix Aviation Corporation's Eclipse-Pioneer division is outstandingly equipped with *several* MB Vibration Exciters. The photograph shows one—MB Model C-25, rated at 2500 pounds of force—vibrating an electronic component to insure dependability under severest conditions. Such testing can uncover, in minutes, trouble that might take months to develop.

VIBRATION PICKUP ANOTHER USEFUL TESTING TOOL

When you want to detect vibration and determine its nature, you'll want an MB Vibration Pickup. While the pickup detects even slightest vibratory motion, it was built for grueling service as well. Model 122 withstands temperatures up to 500°F.



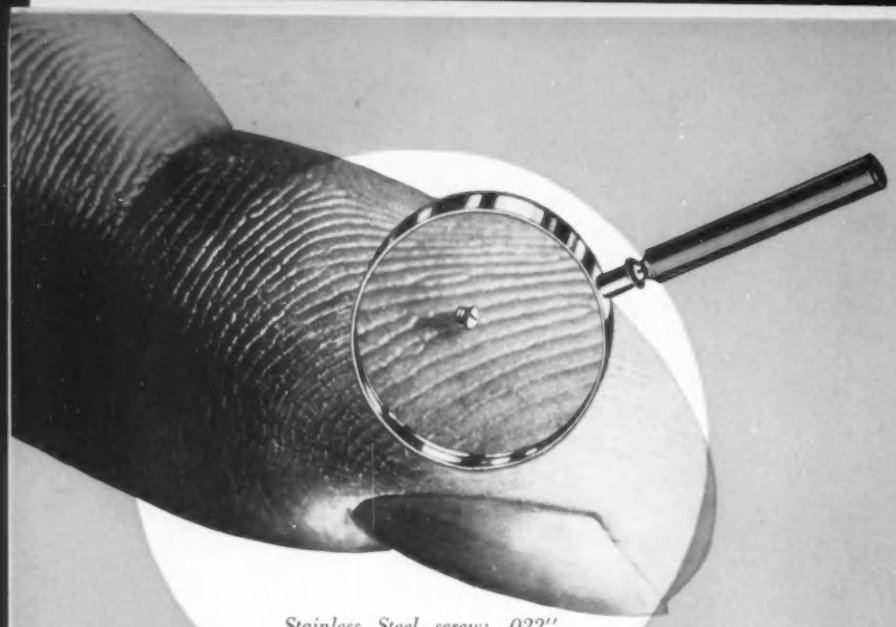
Control panels for all MB shakers, as in the photo above, can be furnished with MB Vibration Meter for use with pickup. This meter gives direct velocity, acceleration and amplitudes of the picked-up vibration.

Bulletins you'll welcome

How to calibrate vibration pickups to 2000 cps—Bulletin C-11-6 reviews the subject comprehensively. Bulletin 1-VE-6 tells all about MB Vibration Exciters. Write for them.

THE MB MANUFACTURING COMPANY, INC.
1060 State Street, New Haven 11, Conn.

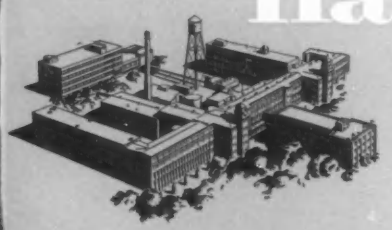
HEADQUARTERS FOR PRODUCTS TO INDUCE VIBRATION...TO MEASURE IT...TO ISOLATE IT



Stainless Steel screw; .022" long; 200 threads per inch; slotted head .036" in diameter.

this is precision

Typical Parts
(actual size)

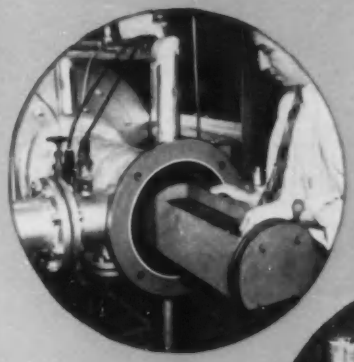


Hamilton Watch COMPANY

Allied Products Division

916 WHEATLAND AVE., LANCASTER, PA.

fabrication



heat treating

gauging and inspection

assembly

backed by

engineering

metallurgy

physical & chemical testing

and complete production help for you

. . . The precision production facilities that make America's finest watch are now available.

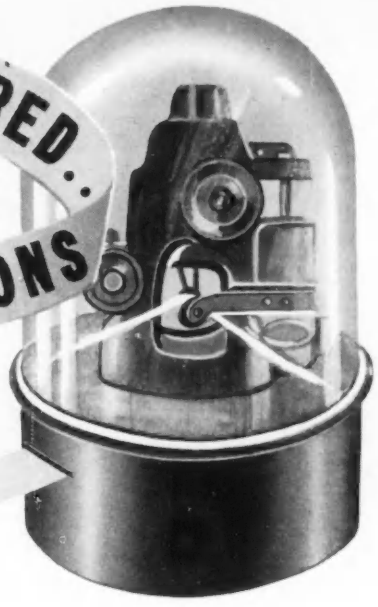
When you need fast production of small precision parts, jewel bearings, or complex devices—machined to microscopic tolerances—assembled in any quantity—checked by extra-expert inspectors—guaranteed to do the job designed every time . . . Here is where to turn:

We will do the job—from your metals or ours. Make the parts, blank them, turn them, profile them, mill them, recess them, thread them, head them. Then we'll heat treat them, test them, burnish them, plate them, assemble them and deliver on time . . . and you can bet the job will be right.

This is a new service, backed by the time-established reputation of Hamilton. It's ready for you TODAY and TOMORROW. Send us your prints: we'll be glad to quote—no obligation, of course.

....RUBATEX ALWAYS PREFERRED..

.FOR GASKETING APPLICATIONS



Some of the Many Manufacturers Now Using Rubatex for Gasketing Applications:

Arvin Industries, Inc.

Boeing Airplane Company

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Ford Motor Company
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Packard Motor Car Company

Piper Aircraft Corporation

Seeger Refrigerator Company

Servel, Inc.

Western Electric Company, Inc.

Willys Motors, Inc.

For air that protects —use Rubatex!

Production-wise

Soft, pliable, light in weight, easy to work with
Can be split or laminated — easily cemented to other materials
Takes up large dimensional tolerances so that glass and plastic parts can be tightened down to a good seal with no danger of breakage
Forms an effective seal — even when applied to irregular surfaces
May be cut to any shape — any size
Offers greater resiliency than other soft rubber materials
Shuts out dirt, moisture, oxygen — even at cut edges

Dollar-wise

Most gasket requirements can be cut from sheet stock in soft, medium or firm grades — ready for immediate shipment
Eliminates any need and expense of special coating or molded-on skin
Cheaper and more dimensionally accurate than molded parts

Performance-wise

Serving more and more industries in so many ways as:
Positive weather seal for auto light assemblies
Effective vapor seal for hatches for oil storage tanks
Air tight, water-tight construction joints
Weather stripping in aircraft stabilizer assemblies
Cushioning effect in hearing aids
Dust-proof seals in electronic devices and precision instruments
Sure-tight insulating seals for refrigerating and air-conditioning equipment

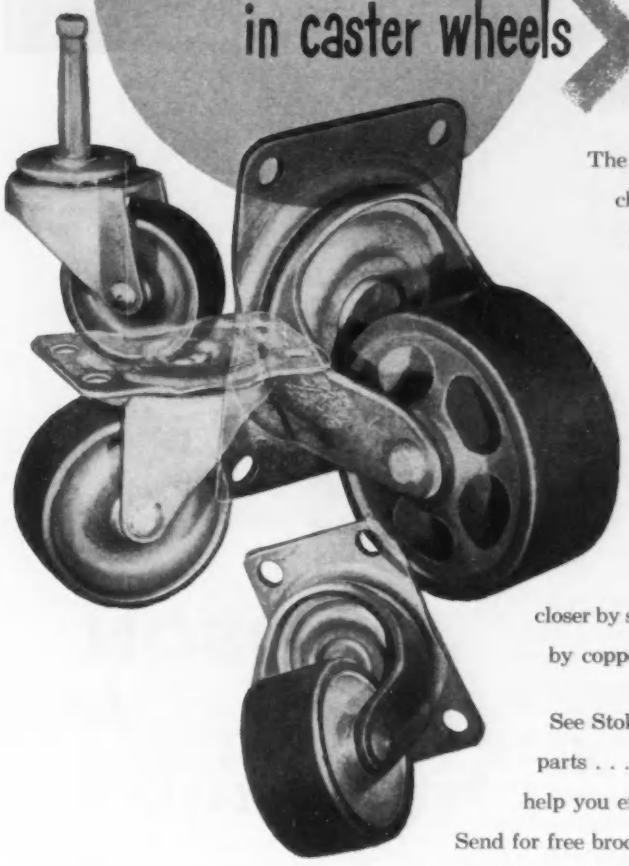
Why not give Rubatex a test? Send details of your specific application, and we'll send samples and recommendations. Write Dept. PE-5, Great American Industries, Inc., Rubatex Division, Bedford, Virginia.

ALSO MANUFACTURERS OF VINYL SHEETS

PIONEER MANUFACTURER OF CLOSED CELLULAR RUBBER

RUBATEX CLOSED CELLULAR RUBBER

Powder metal replaces castings in caster wheels



"We are making a vastly superior product . . . a precision wheel that is truly concentric . . . much stronger and better . . . without any increase in cost."

The Bassick Company, famous for casters, chair controls, automobile and specialty hardware, has replaced cast iron wheels with powder metal wheels in a range from 1¼ to 3 inches diameter with results as quoted.

Many metal parts of irregular contours or complex profiles, or those imposing severe cutting-waste in their machining, are made in powder metal at savings of 50 to 80%.

Tolerances may be as close as ± .001" . . . even closer by sizing; tensiles to 70,000 psi . . . over 100,000 by copper infiltration of powdered iron parts.

See Stokes for the presses to make powder metal parts . . . for the experience and the skills to help you enter powder metal processing with profit.

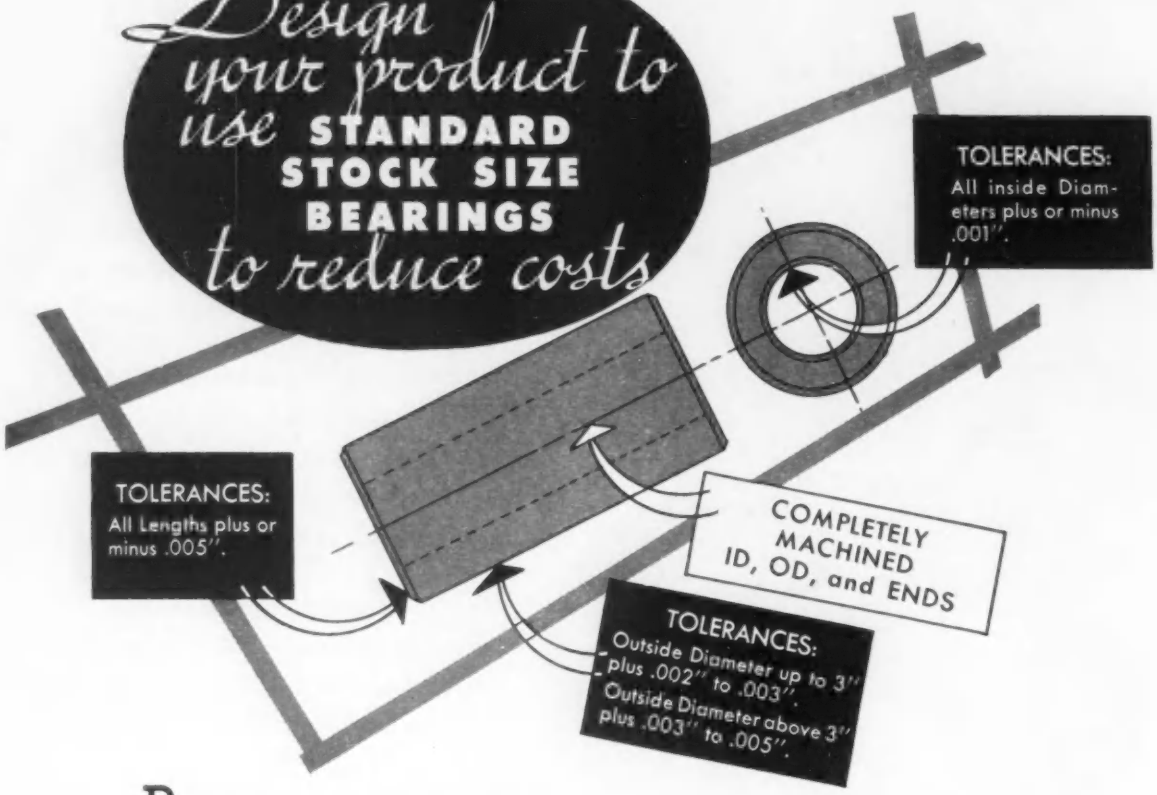
Send for free brochure, "Powder Metallurgy Today" . . . send parts, or blueprints of parts, for study and cost analysis.

F. J. Stokes Machine Company,
Philadelphia 20, Pa.

STOKES

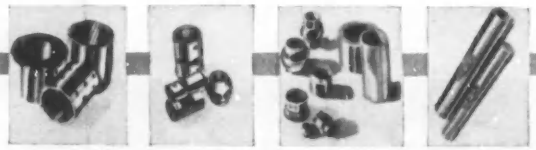
STOKES MAKES Plastics Molding Presses / Industrial Tabletting and Powder Metal Presses / Pharmaceutical Equipment / Vacuum Equipment / High Vacuum Pumps and Gages / Special Machinery

Design your product to use STANDARD STOCK SIZE BEARINGS *to reduce costs*


TOLERANCES:
All inside Diameters plus or minus .001".
TOLERANCES:
All Lengths plus or minus .005".
COMPLETELY MACHINED ID, OD, and ENDS
TOLERANCES:
Outside Diameter up to 3" plus .002" to .003".
Outside Diameter above 3" plus .003" to .005".

PERHAPS only a slight change in product design is necessary to use stock size Johnson GP Cast Bronze Sleeve Bearings. If so, you can cut costs on this item. There are inside diameters available from ¼ inch to 4½ inches, with a selection of wall thicknesses and lengths—over 900 individual sizes. Even if you require slight alterations, slots or oil grooves, the cost still will be much less than for specially made bearings. Many leading manufacturers have adopted stock size Johnson GP Bearings and saved time and money. They are available from your local Johnson Distributor's stock. The Johnson Bearing Catalog lists all stock items . . . write for your copy today.

JOHNSON BRONZE COMPANY
508 South Mill Street, New Castle, Pa.



GRAPHITED CAST BRONZE | ELECTRIC MOTOR | LEDALOYL Self-Lubricating | UNIVERSAL BRONZE BARS

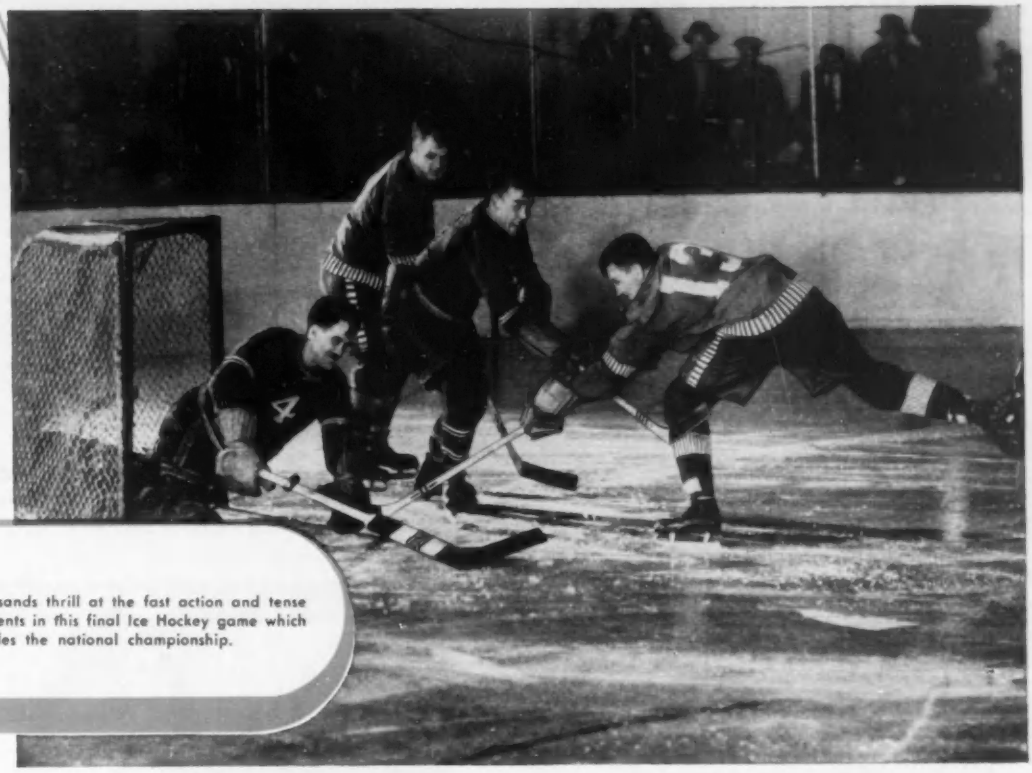
JOHNSON B BEARINGS
Sleeve-Type

JOHNSON
GP *general purpose*
BEARINGS

OVER 900
sizes in stock at
your local distributor's

LOGAN . . . a national participant in major fluid power advancements

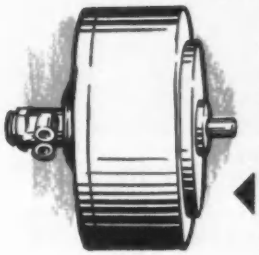
SINCE 1916



Thousands thrill at the fast action and tense moments in this final Ice Hockey game which decides the national championship.

LOGAN ROTATING AND NONROTATING AIR CYLINDERS

FAST-ACTING, POSITIVE CONTROLLED POWER . . . AT LOW COST



Rotating Air Cylinder

NONROTATING—7 STANDARD MOUNTING TYPES

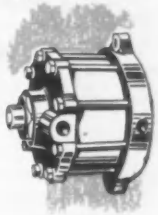
Standard sizes from 1½" to 16" bore; maximum stroke, 18 feet. Special models to meet your requirements.

Logan Features—Larger Ports . . . More Sturdy Construction . . . Maximum Power Without Leakage . . . Permanent Seal Around Piston Rod . . . Standard Models With or Without Cushioning.

ROTATING

Two Standard Styles—Type R with cast iron body; Type K with lightweight aluminum body.

Bore diameter 1½" to 20"; piston stroke 1" to 2"; longer strokes available as special. American Standard adaptations.



Nonrotating Double-Acting Air Cylinder

Consult Logan for your special heavy-duty, mill-type cylinder requirements

LOGAN MANUFACTURES 6,975 STANDARD CATALOGED ITEMS

FREE CATALOG ON REQUEST

AIR CONTROL VALVES, Cat. 100-4 • AIR CHUCKS, Cat. 70-1 • AIR CYLINDERS, Cat. 100-1 • AIR-DRAULIC CYLINDERS, Cat. 100-3
AIR and HYDRAULIC PRESSES, Cat. 51 • COLLET GRIP TUBE FITTINGS, Cat. 200-5 • HYDRAULIC CONTROL VALVES, Cat. 200-4
HYDRAULIC CYLINDERS, Cats. 200-2; 200-3 • HYDRAULIC POWER UNITS, Cat. 200-1 • SURE-FLOW COOLANT PUMPS, Cat. 62

SAVES TIME — Logan — AIR AND HYDRAULIC EQUIPMENT — EFFORT • MOTION

LOGANSPORT MACHINE CO., INC., 812 CENTER AVE., LOGANSPORT, IND.

SYNCHRON®
TIMING MOTOR

...reduce your real costs

...protect your profits

Frequent service calls caused by the use of short-lived motors can run *real* costs 'way up — cut a big slice from net profits — turn customers away.

If your product calls for trouble-free synchronous timing motors, you want the Hansen SYNCHRON. Users report up to 10 years continuous use without servicing, a record equalled by no other motor we know of.

"Work Horse of the Industry" since 1926

SYNCHRON Timing Motors start instantly, never need oiling, pull 8 in. oz. at 1 RPM in any position. They may be stalled continuously without injury, and are available with gear trains to convert any speed.

Advanced engineering, tested materials and precise manufacture under rigid inspection and quality control, assure long lasting dependability and accuracy.

Invitation to Designers

Get complete, concise engineering data showing how easily SYNCHRON Timing Motors, Timing Machines, and Clock Motors may be applied to mechanisms now in production or still in the idea stage.

You are invited to consult HANSEN engineers without obligation. Write or mail the coupon.

HANSEN MFG. CO., Inc., PRINCETON, IND.

Mail coupon for catalog, engineering data.

HANSEN MANUFACTURING CO., INC., Princeton 5, Ind.
Send catalog and engineering data to:

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Firm .....
Address .....
City ..... Zone ..... State .....

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Your Name Plate

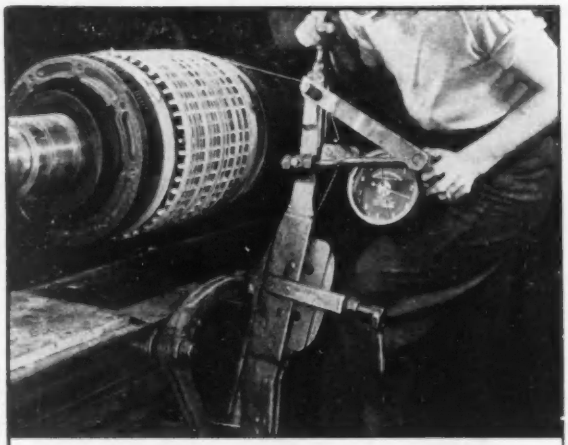
Make it WORTHY Of Your Product

As the maker's "signature," your name plate is one thing that can set your product apart from all others. Make it *distinctive*, and let it reflect the quality you offer.

Let us help you create such a "signature." Our skilled craftsmen, long experience and modern equipment insure finest results. Send a rough sketch or blueprint for design suggestion and quotation.

Write now for "Etched or Lithographed Metal Products," with full color examples of name and instruction plates.

CHICAGO THRIFT-ETCHING CORPORATION
1555 N. SHEFFIELD AVE., CHICAGO 22, ILL., DEPT. B
SUBSIDIARY OF DODGE MANUFACTURING CORPORATION, MISHAWAKA, INDIANA



MEASURING TENSION IN A MOVING WIRE WITH A DILLON DYNAMOMETER

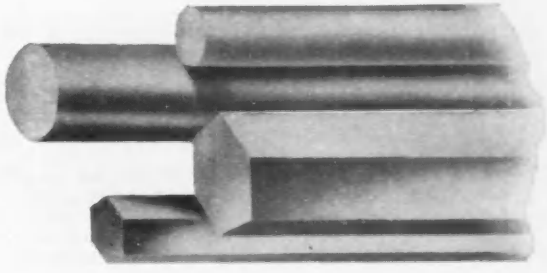
13 different capacities from 0-500 lbs. up to 0-100,000 lbs. Compact, light weight. Supplied with max. pointer and shackles. Instantly reads load applied by hoists, air pistons, turnbuckles, etc. Overload protected.

SALES REPS: Some Territories Open—Write

WRITE FOR ILLUSTRATED LITERATURE AND FREE TENSILE STRENGTH COMPUTER

W. C. DILLON & CO., INC. 14620R Keswick St., Van Nuys, Cal. (Suburb of Los Angeles)

55% in costs saved on this screw machine part by changing from brass to Kaiser Aluminum



Mr. Ken Lemke, Lakeview Screw Machine Company, Ontarioville, Ill., reports:

"We have passed on to our customers a saving of approximately 55% per thousand pieces on this knob since we changed from brass to Kaiser Aluminum stock.

"One reason for this saving is the greatly reduced machine time permitted by aluminum. The brass knob required 12 seconds to produce, and the aluminum knob only 10 seconds. At that rate, it doesn't take long to build up a lot of extra machine time which we use to handle new business.

"Another saving was made possible because aluminum machines to a much better finish than brass. As a result, we simply anodize the aluminum, rather than chrome plating, as we had to do with brass. *And our tool life is much longer with aluminum.*"

Kaiser Aluminum screw machine stock is free machining; provides big material cost savings over other non-ferrous metals; can assure better parts because of its unique combination of properties.

Important suggestion for product designers! Be sure to request an alternate bid in aluminum with each bid you request in another material. This is the easy and logical way to compare both price and suitability of the materials. You'll find that aluminum usually will greatly reduce your per-piece cost and can give you a better part at the same time.

Call in a Kaiser Aluminum engineer. He'll gladly give experienced assistance with alloy selection, design considerations, production techniques. Prompt deliveries of round and hexagonal aluminum screw machine stock now being made by us and our distributors. Look for our local number in the classified telephone directory under the heading "Aluminum." Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Ill.; *Executive Office*, Kaiser Bldg., Oakland 12, Calif.

Kaiser Aluminum

setting the pace—in growth, quality and service

EVEN THE BEST CAN BE IMPROVED

Gerotor offers its New QDB series of small capacity pumps as proof!

Gerotor has redesigned its series of small capacity pumps to give even more . . .

- **FLEXIBILITY**—the QDB can be operated in either clockwise or counterclockwise direction by simply changing the position of one internal plug!
- **RANGE OF APPLICATION**—the QDB can be obtained with an extended shaft to operate another pump in tandem, off of one motor!
- **DEPENDABLE SERVICE**—the QDB is built to give more dependable service over a longer service span than any comparable pump. Its longer life reduces your maintenance and replacement costs.

If you have need for pumps in the QDB range, call on Gerotor.

Gerotor makes a complete line of hydraulic pumps in ranges from .4 g.p.m. to 40 g.p.m. The Gerotor engineers can help you solve your hydraulic pump problems. Write for *free literature* and full particulars.

Check this capacity table . . .

Type	Delivery g.p.m.—1800 r.p.m. Discharge Pressure p.s.i.				
	0	250	500	750	1000
QDB .4	.42	.40	.38	.35	.31
QDB .75	.84	.80	.78	.73	.66
QDB 1.5	1.67	1.62	1.57	1.50	1.42

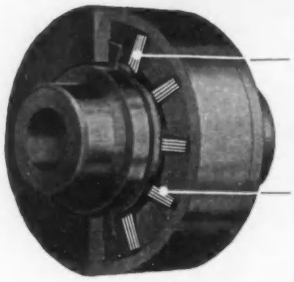
GEROTOR MAY CORP. - Box 86 - Baltimore 3, Md.

GEROTOR
HYDRAULIC PUMPS & MOTORS

HERE'S WHY

KUSHION-TORQ

LENGTHENS EQUIPMENT LIFE



Laminated Kantilever Steel Springs transmit driving action.

Tapered slots move point off driving contact inward as loads increase to automatically stiffen kantilevers.

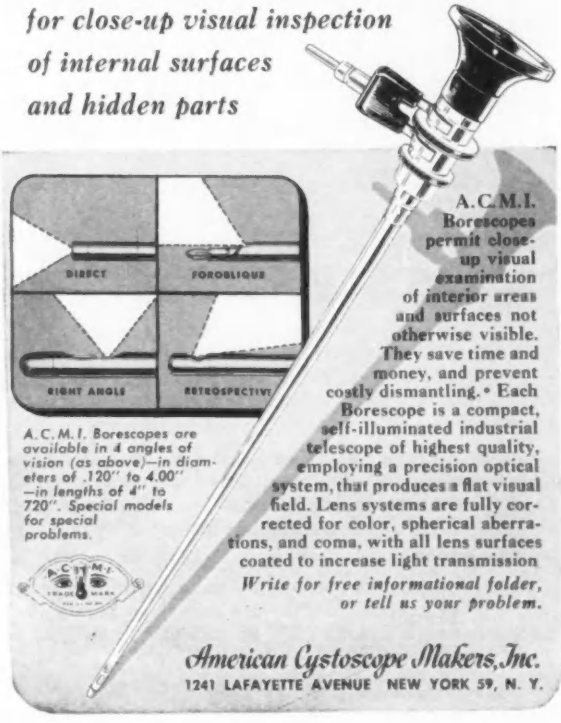
These Brown Coupling features mean equipment is shock and load protected - - - coupling failure is reduced - - - misalignment is corrected - - - radial and torsional vibration are dampened - - - both drive and driven units last longer.

For complete information shown in Bulletin 28P, write Brown Engineering Co., 108 N. 3rd St., Reading, Pa.

BROWN KUSHION-TORQ **COUPLINGS**

A.C.M.I. BORESCOPES

for close-up visual inspection of internal surfaces and hidden parts



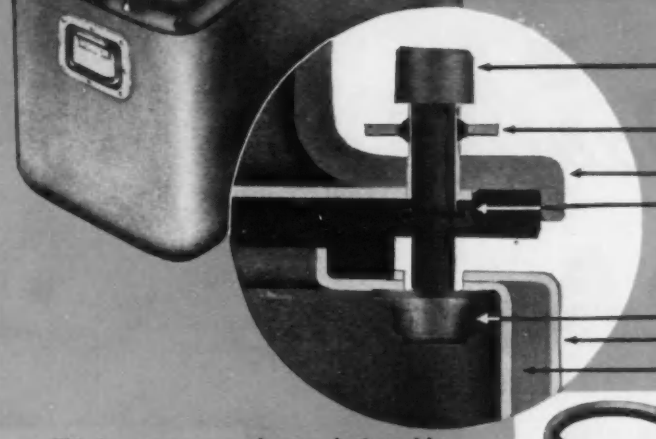
A.C.M.I. Borescopes are available in 4 angles of vision (as above)—in diameters of .120" to 4.00"—in lengths of 4" to 720". Special models for special problems.

A.C.M.I. Borescopes permit close-up visual examination of interior areas and surfaces not otherwise visible. They save time and money, and prevent costly dismantling. • Each Borescope is a compact, self-illuminated industrial telescope of highest quality, employing a precision optical system, that produces a flat visual field. Lens systems are fully corrected for color, spherical aberrations, and coma, with all lens surfaces coated to increase light transmission

Write for free informational folder, or tell us your problem.

American Cystoscope Makers, Inc.
1241 LAFAYETTE AVENUE NEW YORK 59, N. Y.

"THIS CASE IS SEALED!" with 12 Precision Dyna-seals



This immersion proof case, designed by the ConRay Corporation, of Dayton, Ohio, provides a perfect example of efficient sealing with *Precision Dyna-seals*. Engineered for moulding from Fiberglas impregnated thermo-setting resin, the case is designed to protect electronic equipment during storage or shipping. It is immersion proof, vapor proof, resistant to chemical and mechanical damage. *Dyna-seals* allow long term storage without breakdown of sealing action and permit equipment to be placed in service without delay.

Precision Dyna-seals provide the simple solution to many sealing problems. No grooves needed to seal under bolt heads, rivet heads, cap nuts, flanges or special fittings. Excellent for service with petroleum products, water, many other fluids and gases. *Precision* engineers will gladly help you. Write today!

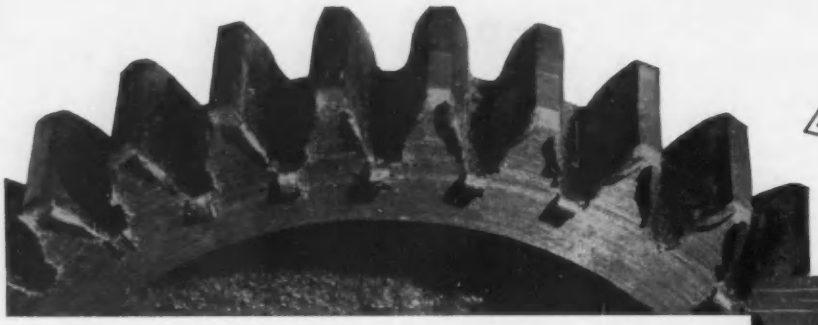
Dyna-seal®

Synthetic rubber sealing member bonded to steel ring for sealing circular flat surface — no grooves necessary.

Precision Rubber Products CORPORATION

"O" Ring and Dyna-seal® Specialists

Dept. 3, Oakridge Drive, Dayton 7, Ohio Canadian Plant at: Ste. Therese de Blainville, Quebec



OSBORN

You get *Quality*

Osborn teams up with engineers to apply brushing power to many deburring, finishing and cleaning operations. This design and production know-how, plus the right brushes for the job assures profitable results.

when you specify
DEBURR AND BLEND

THE lower picture shows the results obtained with an Osborn Brushamatic Machine. This power brushing method does what hand deburring cannot accomplish . . . it removes burrs and feather edges thoroughly and it *blends* surface junctures. The resultant smooth radius of edges decreases stress concentrations, improves service life. Its quality is *uniform* piece after piece.

When you specify this modern method, you also get *faster production!* The gear shown required 3 minutes for hand deburring and only 18 seconds by the Brushamatic method.

Your **O**sborn **B**rushing **A**nalyst will gladly help you find out how this or other push button brushing operations can be applied to your problems. Call your **OBA** today or write *The Osborn Manufacturing Co., Dept. HH-3, 5401 Hamilton Ave., Cleveland 14, Ohio.*

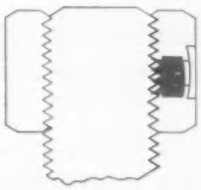
This booklet suggests many ways by which Osborn Power Brushes improve products and lower costs. Write for your free copy of "Automatic Deburring."

Osborn Brushes

OSBORN BRUSHING METHODS • POWER, MAINTENANCE AND PAINT BRUSHES • BRUSHING MACHINES • FOUNDRY MOLDING MACHINES

You get positive locking in any position with

Republic "NYLOK"* Nuts



Here's how the "Nylok" principle works
A nylon plug inserted in one of the sides of the cold-forged nut forces the nut tightly against the opposite threads as the nut is turned on.

*U. S. Pat. No. 2,462,603 and No. 2,450,694 and pending applications.

Locking is positive even when the "Nylok" Nut is seated against a tubular section. And there's no need to pull Republic "Nylok" Nuts up tight. They lock wherever you stop wrenching—eliminating the need for lock washers.

These lock nuts are simple to apply. Either end is up. No special tools, lubricants or techniques are needed. Republic "Nylok" Nuts can be re-used.

Does this give you an idea for your product? Write us for samples, indicating sizes required.

12 WAYS BETTER

Assemble from either end • Can be re-used • Non-galling • Best wrenching characteristics • One-piece • Cold-forged • Won't damage threads No special tools • Lock in any position • No special know-how • No lubricants needed • Ideal for mechanical feeding

SIZES

Finished Series tapped ¼" through 1"
Finished Thick Series tapped ¼" through ½"
Heavy Series tapped ¼" through 1"

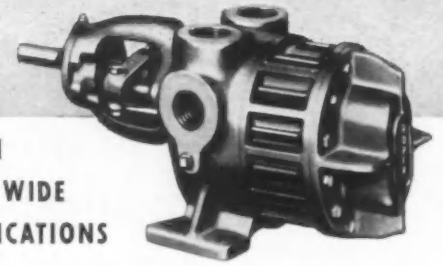
REPUBLIC STEEL CORPORATION
Bolt and Nut Division • Cleveland 13, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, New York

REPUBLIC BOLTS AND NUTS

REPUBLIC STEEL

Install ROPER ROTARY PUMPS

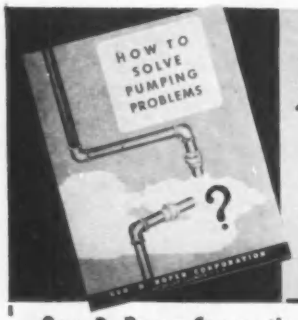
for Positive Results



MODELS FOR AN EXCEPTIONALLY WIDE RANGE OF APPLICATIONS

SERIES F PUMP

SERIES	TYPICAL USES	PRESSURES	SIZES
3600	All Petroleum Handling Grease Compounding Oil Circulating General Transfer	to 60 P.S.I.	40-300 G.P.M.
F	Pressure Lubrication Hydraulic Power Fuel Transfer Lube Oil Transfer	to 300 P.S.I.	1-300 G.P.M.
K	Pressure Lubrication Hydraulic Service Industrial Oil Burner Fuel Supply	to 150 P.S.I.	¾-50 G.P.M.
H	Hydraulic Power Test Equipment Pressure Lubrication High Pressure Coolant	to 1000 P.S.I.	5-75 G.P.M.



NEW! **LATEST EDITION OF THIS BOOKLET NOW READY FOR YOU! SEND FOR YOUR FREE COPY**

A valuable guide covering important fundamentals of estimating requirements of the average pumping job. It includes tables, charts, sample problems, and other pertinent data. SEND COUPON BELOW.

Geo. D. Roper Corporation, 375 Blackhawk Park Ave., Rockford, Ill.

Please Send Booklet—"How to Solve Pumping Problems"

NAME.....

ADDRESS.....

CITY..... STATE.....

ROPER *Rotary Pumps*

PRECIOUS AND BASE METAL WIRE AND STRIP PLATING..

by NARL

GOLD, SILVER or PLATINUM plated on wire as small as 0.0005 inch diameter.

NARL continuous process electroplating equipment and controls assure compliance with the most exacting specifications.

Large size wire plating with various metals or alloys - to protect against corrosion - to resist abrasion - to improve adhesion of insulation.

FINE RIBBON and STRIP electroplating up to 3½x0.025 inch size.

Copper plating on aluminum

Copper plating on stainless steel for die lubrication

SMALL PARTS PLATED with: platinum, gold, silver, solder, etc., such as:

Electrical connectors, and contacts

"Tinkertoy" components

Inquiries welcomed on difficult wire, strip or small parts plating.

Research • Development Production

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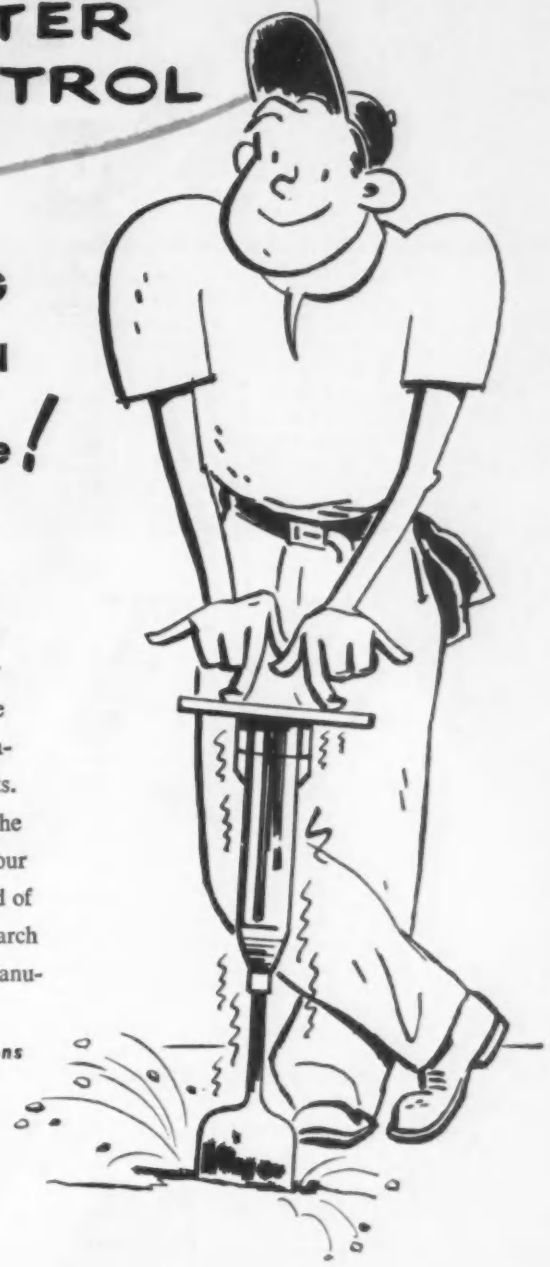
725 LEXINGTON AVE., KENILWORTH, N. J.

PHONE: CHESTNUT 5-7373

JUST A MATTER OF CONTROL

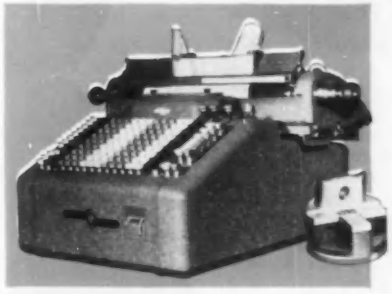


LORD ENGINEERING CONTROLS VIBRATION

. . . anywhere!

The difference between a good product and a better one is often just A Matter Of Control—control of vibration and shock which may be damaging your product. Pioneers in solving vibration problems for many industries, Lord Manufacturing Company is well qualified to assure you of better performance from your products through the use of Lord Vibration Control Mountings and Bonded-Rubber Parts. Our Engineers will be pleased to help you in the analysis of the vibration which may damage your product and in the selection of the correct method of control. Lord Engineering means Materials Research —Engineering Research—Product Design—Manufacturing Know-How for your application.

Over 27,000 designs and their variations from which to choose.



Here is one example of Lord Engineering on sensitive business machines. The Burroughs Sensimatic Accounting Machine is supported on LORD Mountings to reduce noise and cushion shock.

LOS ANGELES 28, CALIFORNIA 7046 Hollywood Blvd.
DALLAS, TEXAS 313 Fidelity Union Life Building
PHILADELPHIA 7, PENNSYLVANIA 725 Widener Building
DAYTON 2, OHIO 410 West First Street
DETROIT 2, MICHIGAN 311 Curtis Building
NEW YORK 16, NEW YORK 230 Madison Avenue
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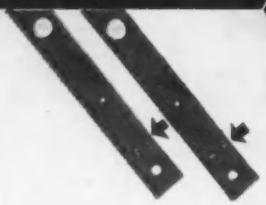
LORD MANUFACTURING COMPANY • ERIE, PA.

LORD BONDED RUBBER

Headquarters for
VIBRATION CONTROL
FOR 30 YEARS



CROSSBAR CONTACTS FOR MINIATURE RELAYS

Originally designed for use in telephone relays, crossbar contacts are now widely used for miniature relays and contacts. Assembly is speeded and eased because alignment of contacts is not critical.

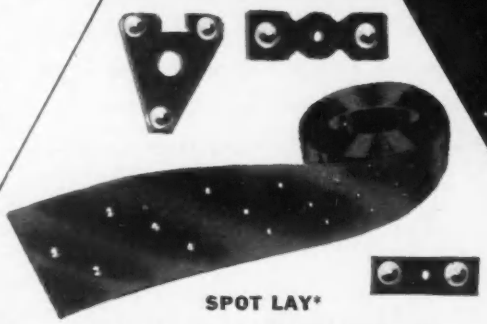
Major savings are made by attaching with Makepeace machines which cut off and weld automatically, and in the reduction of waste of precious metal. Laminated precious metal capped contact tape is produced in production runs and supplied on reels. There is no handling of individual tips.

Better Electrical Contacts by Makepeace

For more than half a century, Makepeace has specialized in and perfected the production of laminated and solid precious metals. Tolerances are held to the closest possible margin. Electrical qualities, strength, hardness and temper meet the most exacting specifications. As a result, manufacturers of electrical equipment look to Makepeace as their most dependable source of supply for materials of the highest quality and the longest service life.

RAISED LAY

When raised lay is used, costly assembly operations are reduced to blanking costs and no precious metals are wasted. That is because one or more strips of silver are bonded to a base metal in the form of a ridge or a bar. Cold, hard rolling produces the required temper in the base metal and dense hard contact surfaces for the most efficient electrical and mechanical qualities.



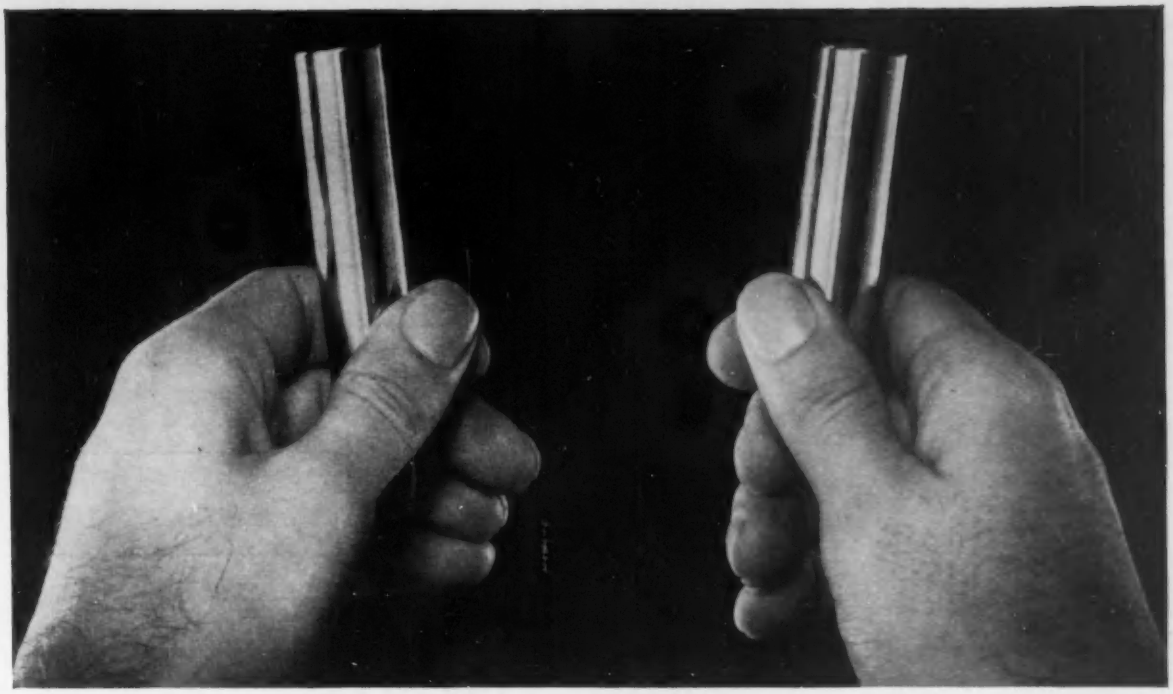
SPOT LAY*

Developed and perfected by Makepeace, this exclusive process brazes slugs of precious metal in strip stock, positioning them exactly where needed. This new, economical and efficient material permits manufacturers to produce rotors in switches and small bridge contacts at lower costs and with improved life performance.

*Patented

PRECISION RECTANGULAR WAVEGUIDE TUBING
MICROWAVE COMPONENTS • MICROWAVE TRANSMISSION ASSEMBLIES • ELECTRICAL CONTACT MATERIAL • FORMED ELECTRICAL CONTACTS
CROSSBAR WELDED CONTACTS • SLIP RING AND SLIP RING ASSEMBLIES • BRUSH ASSEMBLIES
PRECIOUS METALS CLAD TO BASE METALS
SHEET—TUBING—WIRE AND ASSEMBLIES
SENDZIMIR PRECISION ROLLING

D. E. MAKEPEACE COMPANY
Division of Union Plate and Wire Co.
Attleboro, Mass.
Sales Offices: New York • Chicago • Los Angeles • Columbus

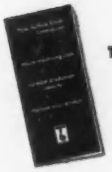


SAME MATERIAL—SAME SPECIFICATIONS

Why did one of these parts cost twice as much to machine?

The answer may well show up in *your* production costs. The surface finish on the part at the left was *controlled*, using a Brush SURFINDICATOR*, to meet specifications. The surface finish on the other part was *guessed at* and the part was overfinished, exceeding specifications. Cost data shows that furnishing a 32 microinch finish, where a 125 microinch finish would be satisfactory, *doubles* the machining cost.

You no longer have to guess at surface roughness and spend needless money in overfinishing. The Brush SURFINDICATOR permits you to measure surface roughness easily and quickly on the production line. Laboratory techniques are not required — your shop personnel can quickly learn to make accurate measurements after brief instruction.



TRY IT YOURSELF! Write for a copy of this booklet. It describes how surface finish control can reduce your machining costs, increase production capacity and help improve your products. Better yet, ask for a demonstration of the SURFINDICATOR in your plant, by a Brush engineering representative. Send coupon now. Brush representatives are located throughout the U. S. In Canada: A. C. Wickman, Ltd., Toronto. Brush Electronics Co., Cleveland 14, Ohio.

*Trade-Mark

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INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZO-ELECTRIC MATERIALS • ACOUSTIC DEVICES
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ULTRASONIC EQUIPMENT

formerly
The Brush Development Co.
Brush Electronics Company
is an operating unit of
Clevite Corporation.

SURFINDICATOR* makes surface measurements easy!

The Brush SURFINDICATOR is easy to use, portable and accurate. It can be set up anywhere in the plant where 115 volts a.c. is available. The operator simply guides the pickup over the part, and reads surface roughness in microinches on the meter.

Brush Electronics Company, Dept. L-5
3405 Perkins Avenue, Cleveland 14, Ohio

☐ Please send free copy of "Surface Finish Control".

☐ Have your nearest representative demonstrate the portable SURFINDICATOR to me.

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Direct alignment in remote control or power transmission around corners is a saving in space and operation.

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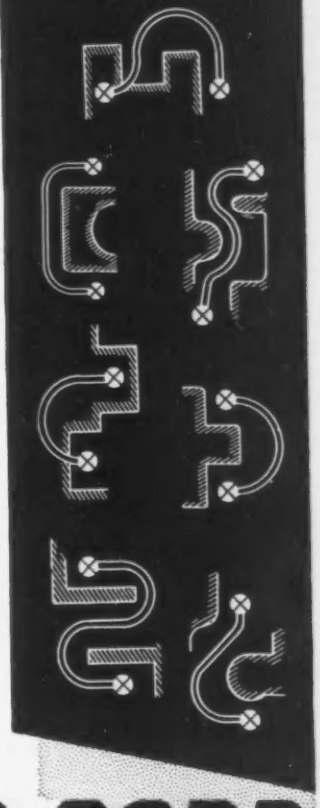

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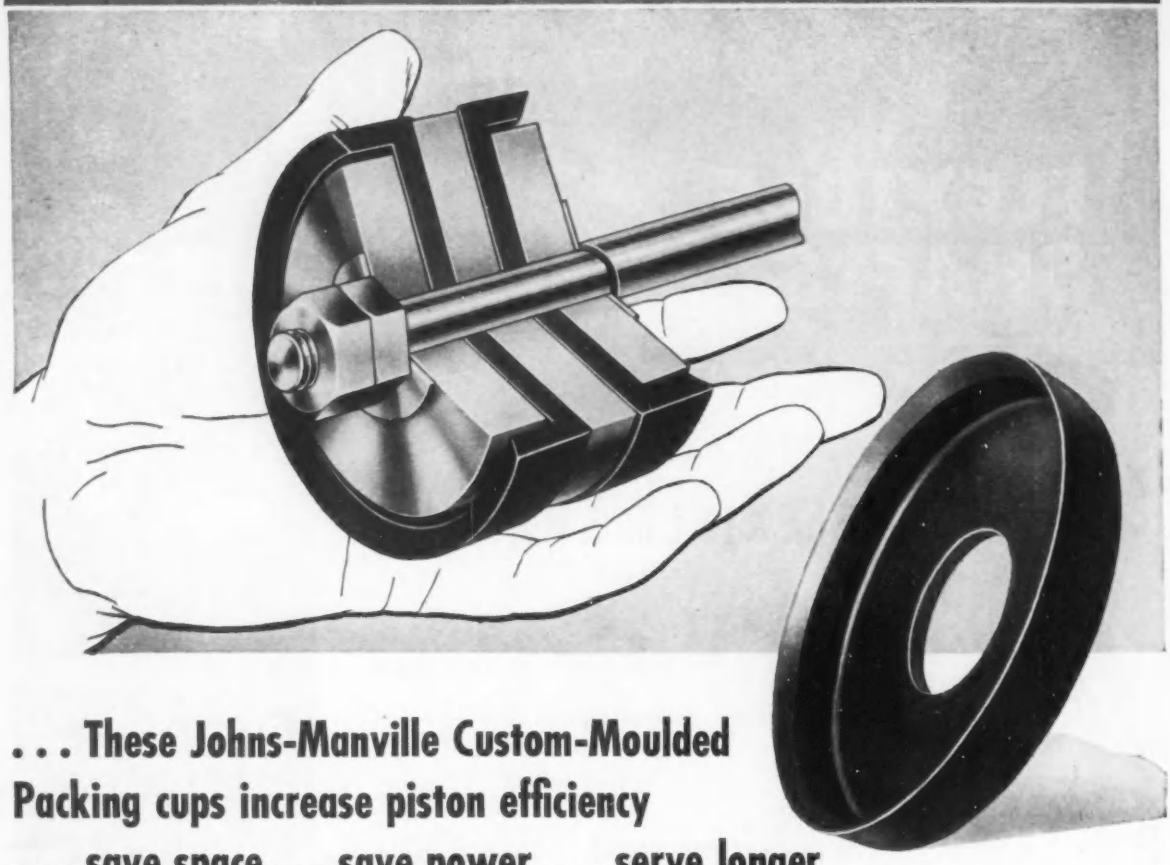

. . . These Johns-Manville Custom-Moulded Packing cups increase piston efficiency . . . save space . . . save power . . . serve longer

TYPE A . . . The Type "A" J-M Moulded Packing Cup is the "standard" for use on the pistons of pumps and on various hydraulic and pneumatic mechanisms. The lip forms a tight seal under discharge pressure, but relaxes on the reverse stroke, reducing friction and conserving power.

TYPE B . . . This type of cup is essentially the same as Type A, except that the leading edge of the lip is square instead of beveled. This construction provides greater strength where the lip may be exposed to distortion or excessive wear due to openings in cylinder walls.

Johns-Manville Moulded Packing Cups can help you improve piston designs. They provide a highly efficient seal . . . improve equipment performance . . . lower operating and maintenance costs. These custom-made packings are extensively used on all types of slow moving pistons and rams operating under high or low pressures and temperatures.

Johns-Manville Moulded Packing Cups may be used on practically all air or hydraulic-operated cylinders. For instance, those which are in such equipment as reciprocating pumps, hydraulic jacks and presses, pneumatic chucks, governors, lift trucks, grease guns, valves, drilling and boring machinery . . . or on any other equipment where efficient piston design is essential.

You have your choice of a number of styles and compositions of these precision-moulded cups to meet temperatures and pressures encountered in hydraulically operated equipment. Types "A" and "B," shown here, are most widely used on inside-packed pistons with the outside edge or lip contacting the cylinder wall or liner. Other types are available, however, for other services.

If you would like more information on these or other types of Johns-Manville Custom-Made Piston Packings, get in touch with your Johns-Manville Packings Distributor, or write Johns-Manville, Box 60, New York 16, N. Y.

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Johns-Manville PACKINGS & GASKETS

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Tight, vibration-proof fastenings—*for the life of your product.*

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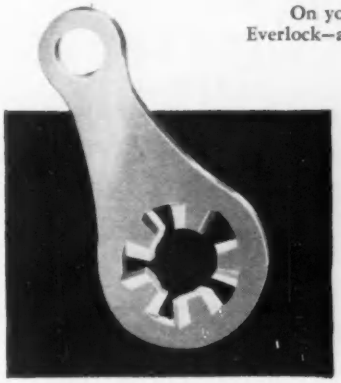
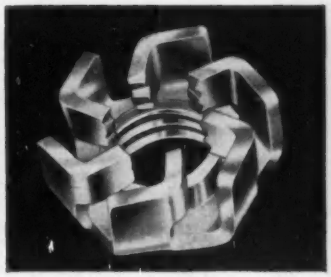
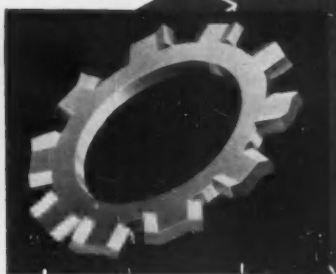


TERMINALS
Plain and lock types.



LOCKNUTS
Both National fine and National coarse threads.



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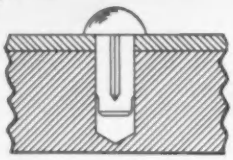

Quick, simple insertion... Drill Hole and Drive Stud with a single blow

Driv-Lok Studs save time and reduce costs in fastening name plates, covers, brackets, panels, etc. to heavier sections and for countless other applications involving light-to-heavy member fastening. Once installed, Driv-Lok Studs will not vibrate loose or fall out—yet they can be easily removed without damage to components. Made in 3 head styles. Write for illustrated catalog sheet, prices and samples.

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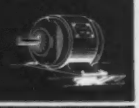

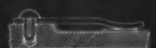

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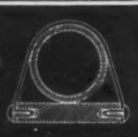

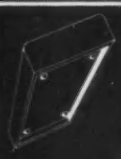

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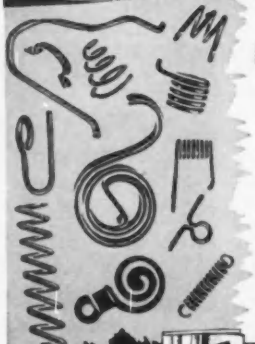

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Kropp Forge Co. 409 Rockford Press equipped with a FAWICK Package Conversion Unit consisting of FAWICK Ventilated 37-VC650 Air-Ring Clutch and FAWICK 28VC650 Air-Ring Brake.

Photo courtesy of Kropp Forge Co.

The famous FAWICK completely ventilated Type VC Air-Ring Clutch which features (1) cooler operation inherent in drum clutch design, (2) isolation of the operating tube from the heat-generating friction surface, (3) rivsted, replaceable friction lining, and (4) loose, expanding operating tube which can be replaced without removing the clutch from the shaft.

For full information on these and other FAWICK units, write for Bulletins 400-A and ML-102.

Among all types of industrial clutches and brakes, only FAWICK Airflex provides *all* of the proved-performance advantages and features found with drum type operation.

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These are not mere claims, but performance-proved facts—proved by thousands of FAWICK Airflex Clutch and Brake installations in the industrial production field.

FAWICK engineers will be glad to show you the many operating and safety advantages of FAWICK Airflex Clutches and Brakes as applied to your specific machines—no obligation of course.

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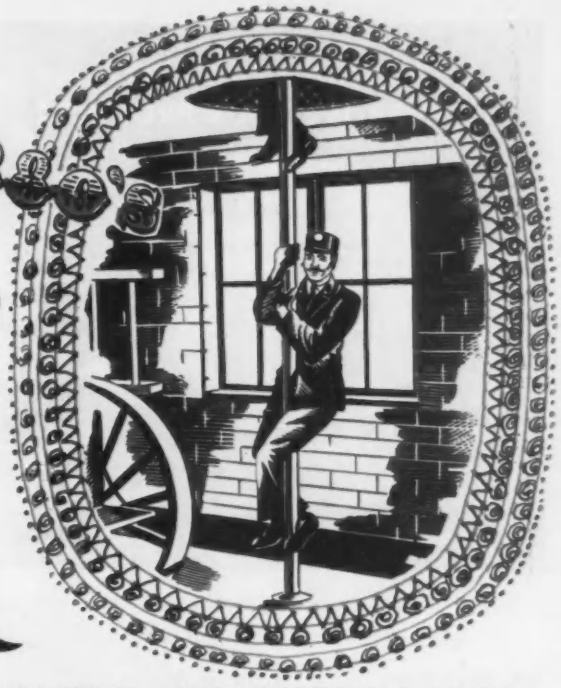
WAD 4050 B

BACK IN THE 1880's



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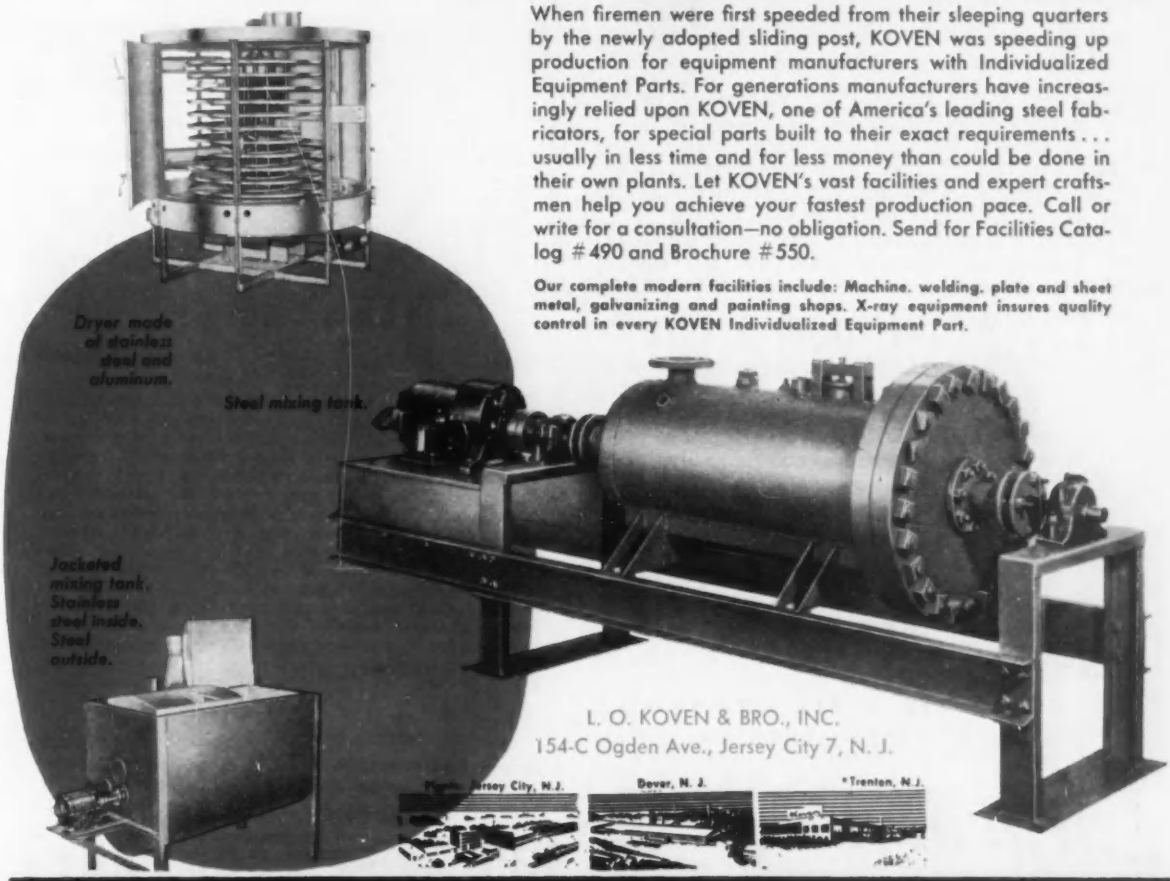
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Carpenter FREE-CUT INVAR "36"
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The plunger of the syringe shown above is made from Carpenter Free-Cut Invar "36" to assure holding to constant dimensions from room temperatures to sterilizing temperatures. The fitting used for the aircraft instrument was originally made from regular invar. A change to Carpenter Free-Cut Invar "36" still gives the same expansion properties, plus this bonus: elimination of extra operations and bench work in machining . . . output increased 500%!

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technical bulletin

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SPECIFICATIONS

Weight: 13.75 lbs. **Stroke:** 3¾ inches.
Working Load: 3400 lbs. normal tension; 8200 lbs. maximum tension.
Speed of stroke with 3400 lb. load: .55 inches per second on 28 volt DC system.
Maximum Static Load: 18,750 lbs. tension.
Load Limit Switch Actuation: on at 7500 lbs.; off at 9000 lbs.
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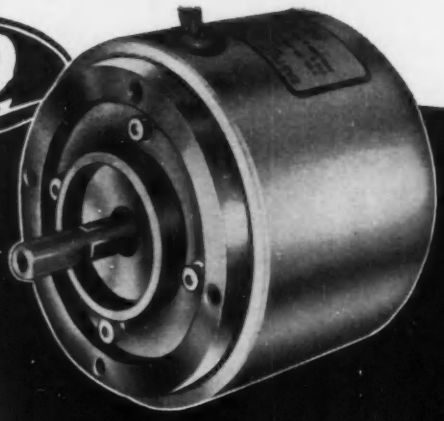
EAD

sine wave alternators give you less than 2% distortion!



Whether your needs are for an extremely pure sine wave voltage or for appreciable power output, EAD will make an alternator tailored to your requirements. Models are available from 30 to 1000 cps at voltages from 6 to 115 volts and in a wide range of frame sizes.

DUAL OUTPUT UNITS AVAILABLE WITH PHASE ANGLE OF ANY SPECIFIED VALUE HELD TO 1° OR BETTER

In addition to standard single frequency types, forms can be made with two separate outputs of either the same or integrally related frequencies. Phase angles between these two output waves can be held to extremely close tolerances.

Eastern Air Devices is a pioneer in the field of small permanent magnet alternators. No matter what your requirements may be, check with EAD first!

FEATURES

1. **Low Distortion:** Less than 2% distortion of open circuit voltage wave even in smallest sizes.
2. **Dual Frequency:** Models available with two separate, yet integrally related, output frequencies. Phase angle between two outputs can be any specified value.
3. **Wide Size Range:** Compact design. Models available in sizes as small as 1 inch in diameter.
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5. **Military Specifications:** EAD alternators can be manufactured to meet the most exacting military specifications.

EAD

EASTERN AIR DEVICES, INC.

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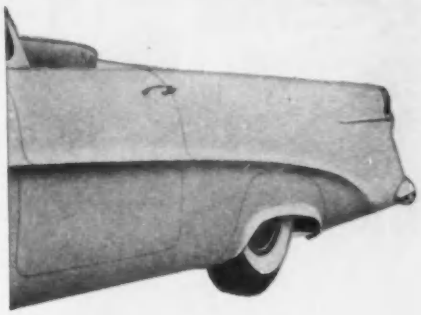
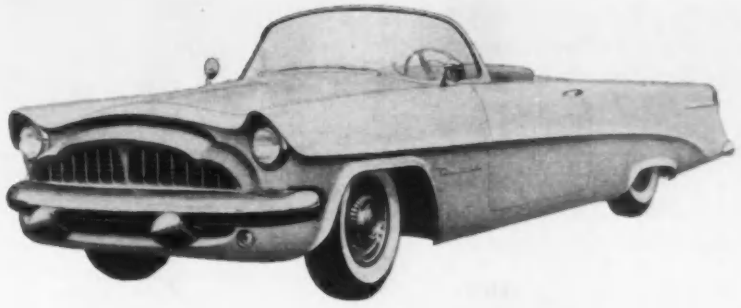
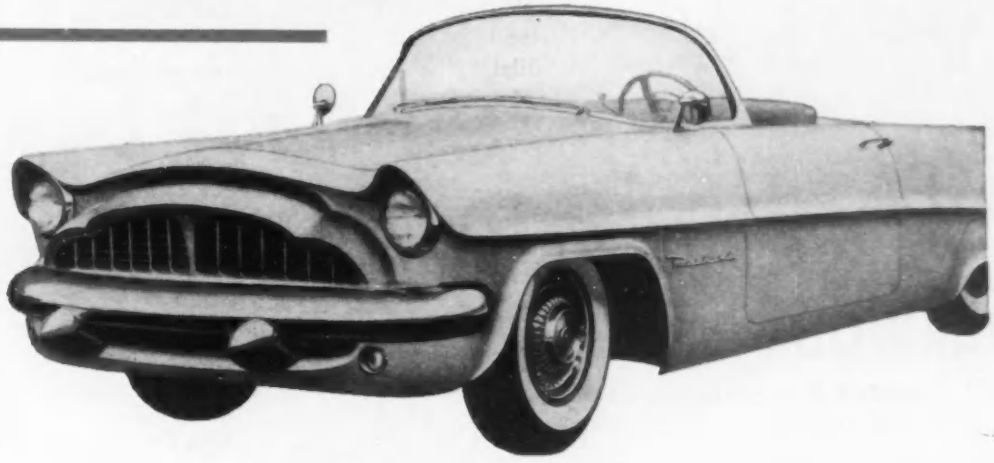


The body beautiful and super-strong*





*thanks to **PLASKON**® Polyester Resin

The Exciting new Experimental Packard "Panther" Daytona has a body molded with the wonder combination of PLASKON 9500 Polyester Resin and fiber glass. It is the first product of Packard's long-term engineering studies in the use of new materials. Way ahead in functional designing and performance, the Panther's body is as strong as, yet tougher than steel . . . it is dent resistant, won't rust or rattle, and can be repaired simply and at a fraction of the cost of metal.

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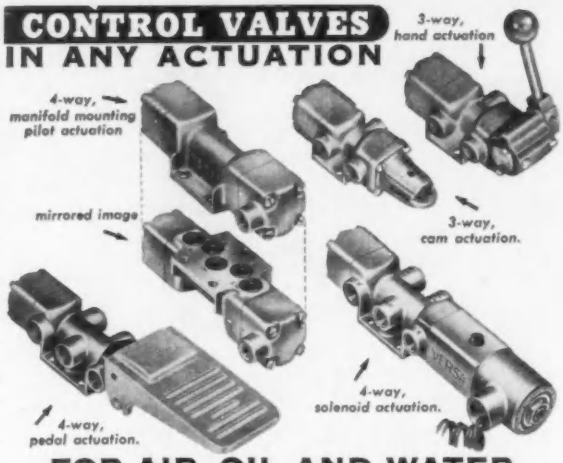

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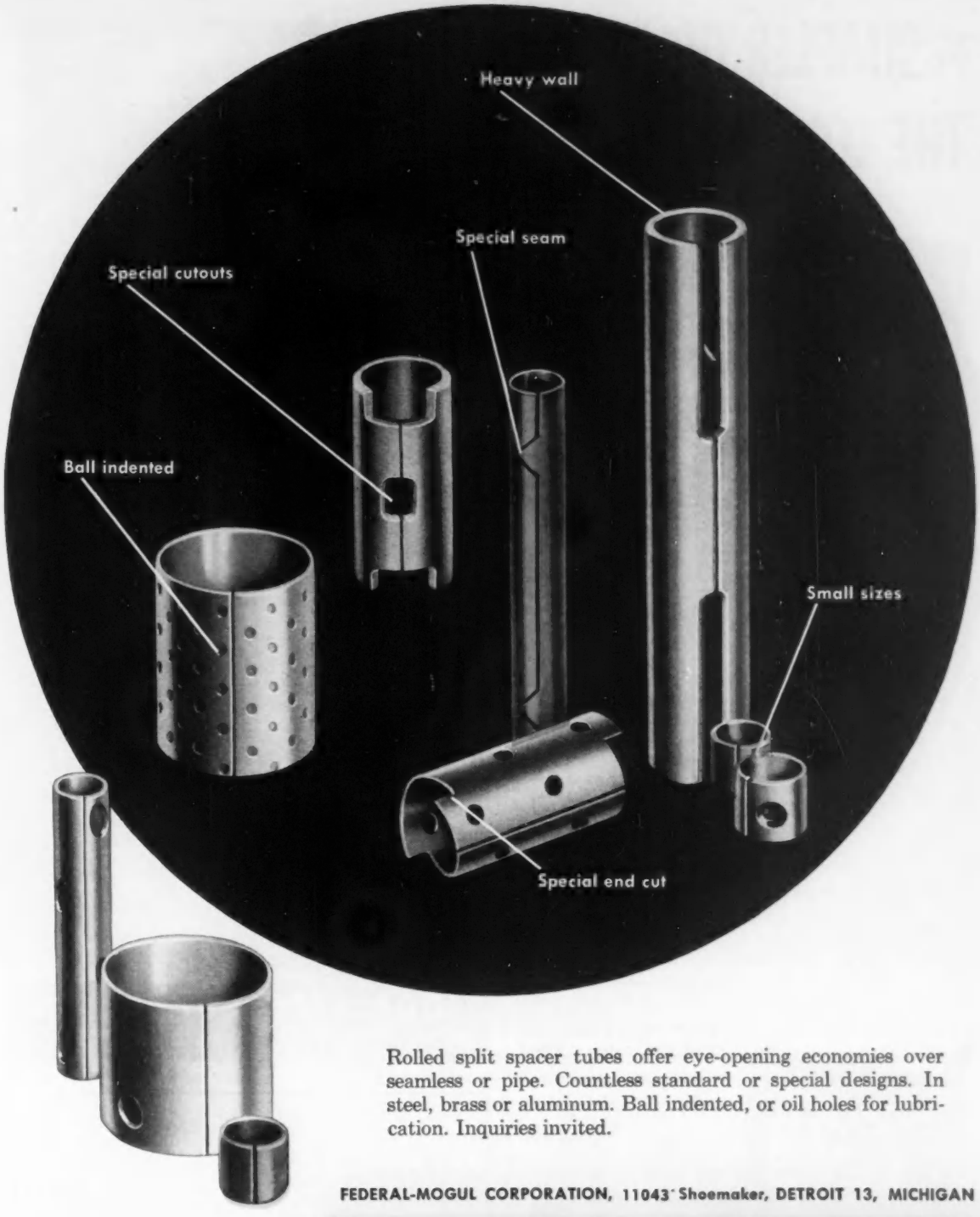

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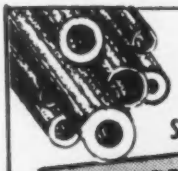

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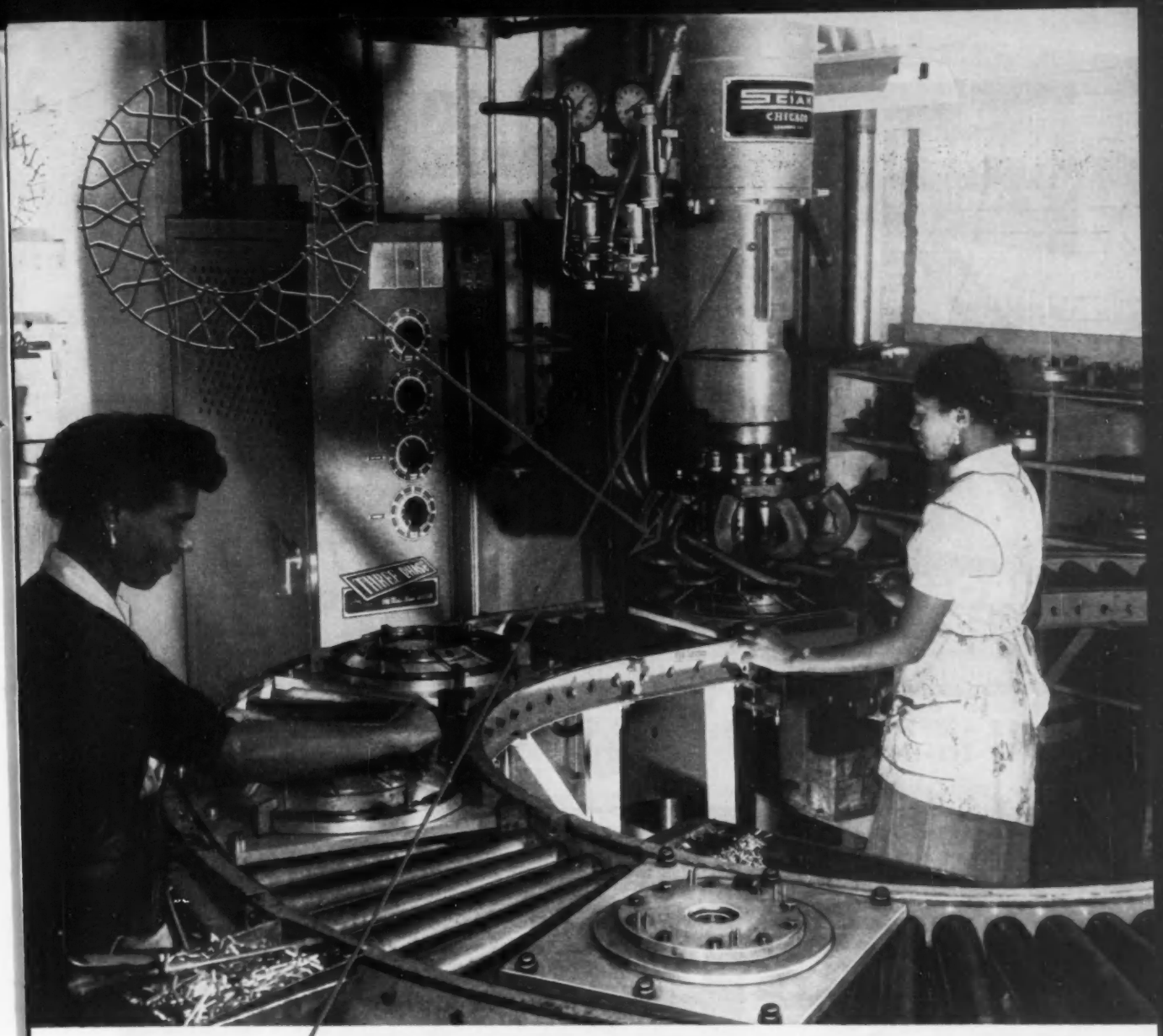
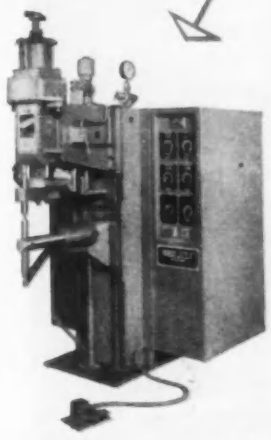


40 Spokes of .430 Stainless Resistance Welded to 2 Rings in Simulated Wire Wheels



CASCO PRODUCT'S (Bridgeport, Conn.) design of their complex, 42 piece wire wheel assembly presented serious problems of high production, allowable tolerances for positive fit, and cost of fabrication. Sciaky patented Three-Phase resistance welding provided most suitable answers to all requirements.

Two standard Sciaky welders complete the entire assembly in only four operations at a production rate of over a thousand per day. No skilled workers are required to produce assemblies that satisfy rigid inspection for alignment and set-down of welds. Sciaky Three-Phase produces smooth fillet welds eliminating special metal finishing. For complete details, write for R.W.A.W., Vol. 3, Number 9.

Resistance welding of Casco wire wheels is another fine example of Sciaky's basic thinking—welders designed to do *more useful work* at *lowest operating cost* with *maximum reliability*.

Largest Manufacturers of Electric Resistance Welding Machines in the World

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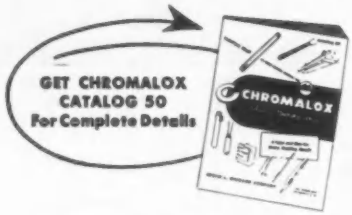

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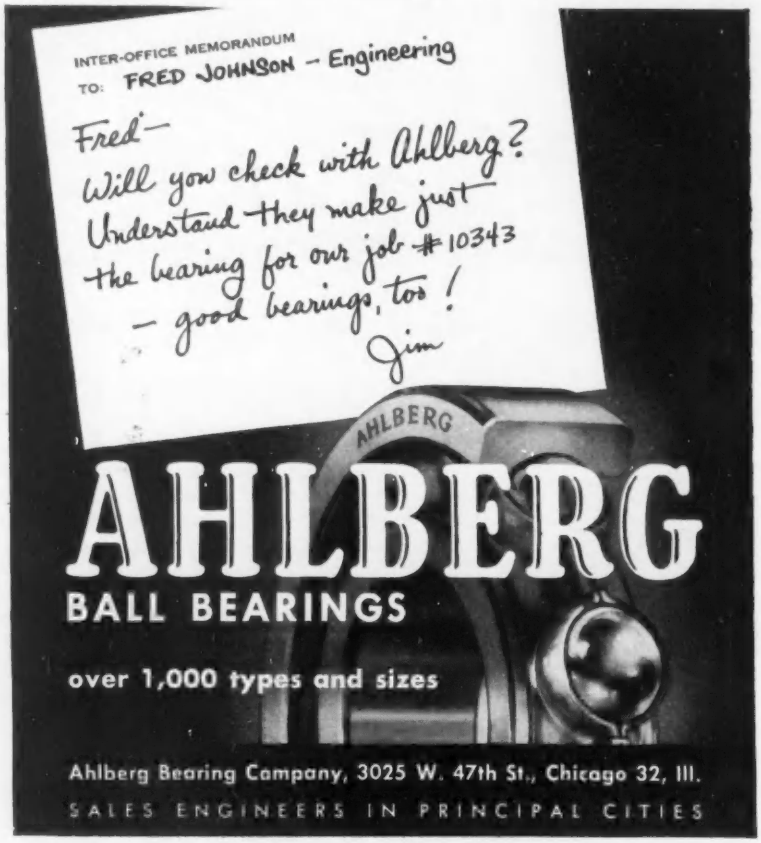

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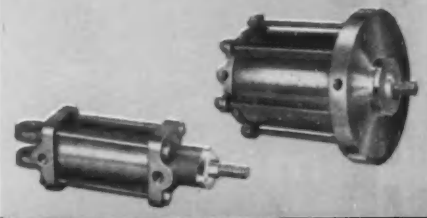

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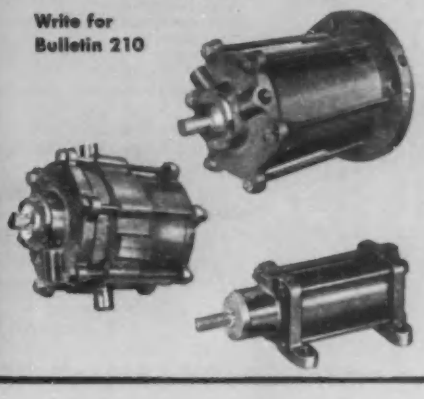

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Designed for smooth, positive and accurate control of air-operated equipment. Bronze discs lapped to perfect seal with seats. Packless design. For hand, foot or electrical operation. Sizes from ⅛" to 1¼" I.P.S.

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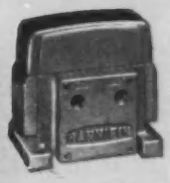
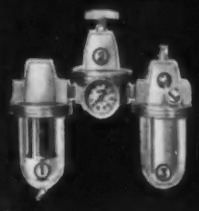


Hannifin "Directair" electrically controlled air-operated disc valve

Foot-operated treadle valve (Also spring return and rotary types)

Standard hand control valve (Single or duplex)

AIR WARDEN



Hannifin "Air Warden" units are the finest protection possible for air-operated equipment. Complete units include: (1) Air Filter which removes grit, dirt, scale, moisture, emulsified oil; (2) Self-Bleeding Pressure Regulator that assures absolute stability of secondary pressure; and (3) Atomizing Type Lubricator fillable without shutting off air pressure. Components also sold separately. Write for Bulletin 1010B

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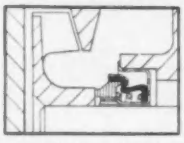
- √ Quickly Installed
- √ Extremely Compact
- √ Low in Cost

STATIONARY SEALING HEAD TYPE 11-A

A. Seal Retainer.
B. Synthethic Rubber Bellows.
C. Metal Band.
D. Spring.
E. Holding Dents.
F. Precision-Lapped Sealing Washer.



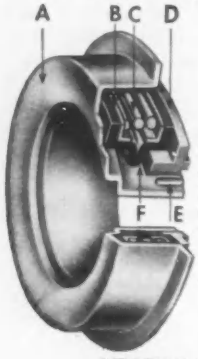
This pressed-in packaged sealing unit is designed with the spiral steel spring inside of the synthetic rubber bellows to protect it against corrosion.

The spring clamps the flange of the bellows tight against the bottom of retainer and the metal ferrule squeezes the top portion of the bellows against the "Teeplelite" washer.

This liquid-tight seal is especially recommended for small shafts on *hot or cold water, oil, gasoline, kerosene, soapy water.*

Use this seal on: *Low Pressures* to 35 PSI
Temperatures −65°F. to +220°F.

STATIONARY SEALING HEAD TYPE 6-A



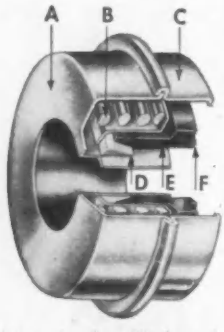
A. Seal Retainer.
B. Metal Ferrules.
C. Spring.
D. Precision-Lapped Sealing Washer.
E. Holding Dents.
F. Synthetic Rubber Bellows.

This pressed-in packaged sealing unit is designed with a spiral steel cadmium plated spring (stainless or bronze optional) assembled between two metal ferrules which clamp the flanges of the synthetic rubber bellows tightly against the retainer shell and the "Teeplelite" washer.

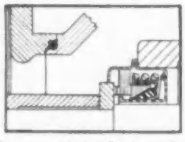
This liquid-tight seal is especially recommended for small shafts on *hot or cold water, oil, gasoline, kerosene, soapy water.*

Use this seal on: *Medium Pressures* to 75 PSI
Temperatures −65°F. to +220°F.

STATIONARY SEALING HEAD TYPE 9-A



A. Seal Retainer.
B. Spring.
C. Sleeve.
D. Wedge of Teflon.
E. Sealing Washer.
F. Precison-Lapped Face.



This pressed-in packaged sealing unit is designed to use a wedge sealing ring of Teflon*. This wedge shaped sealing ring closely fits the inner sleeve of the retainer and makes a liquid-tight contact with cone surface of carbon washer.

The result is a liquid-tight seal which is especially recommended for *hot oil, and all chemical liquids or gases, hot or cold.*

Use this seal on: *High Pressures* to 150 PSI
High Temperatures +485°F. *Low Temperatures* −120°F.

Write for fact-filled catalog. Crane Packing Company, 1845 Cuyler Ave., Chicago 13, Ill.

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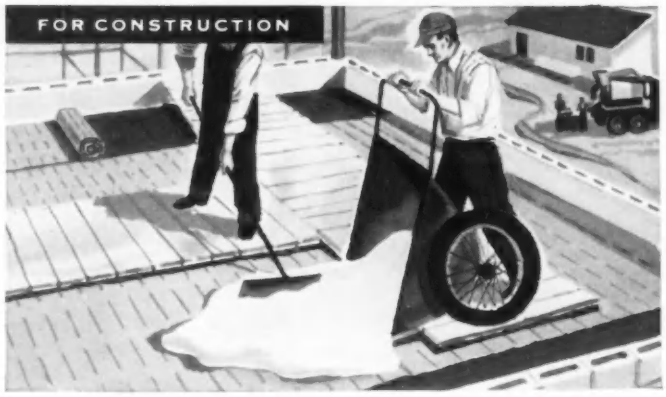

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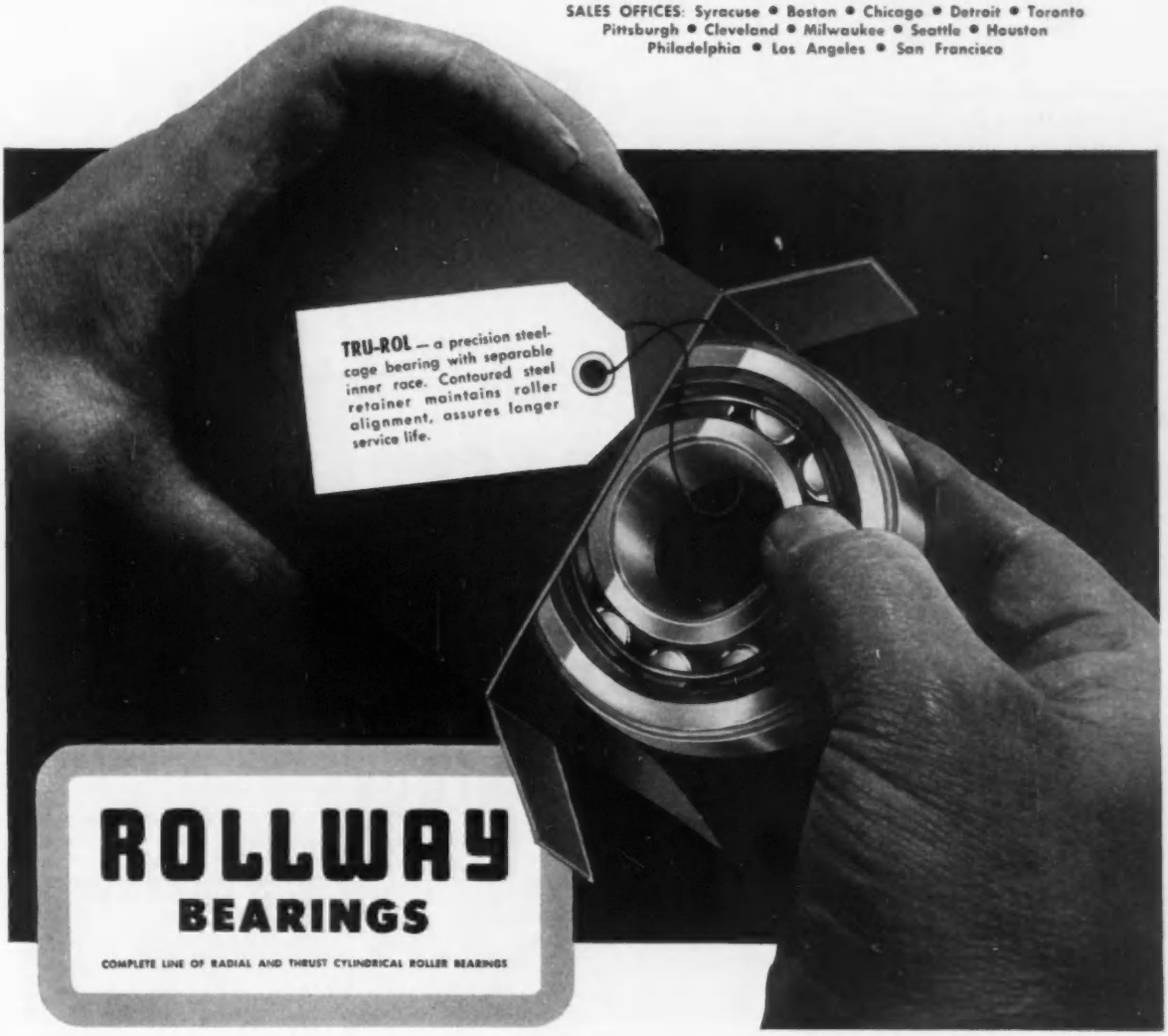
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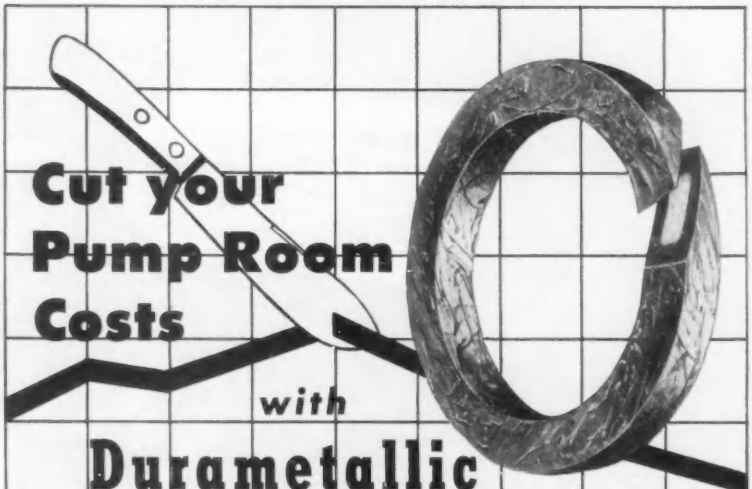

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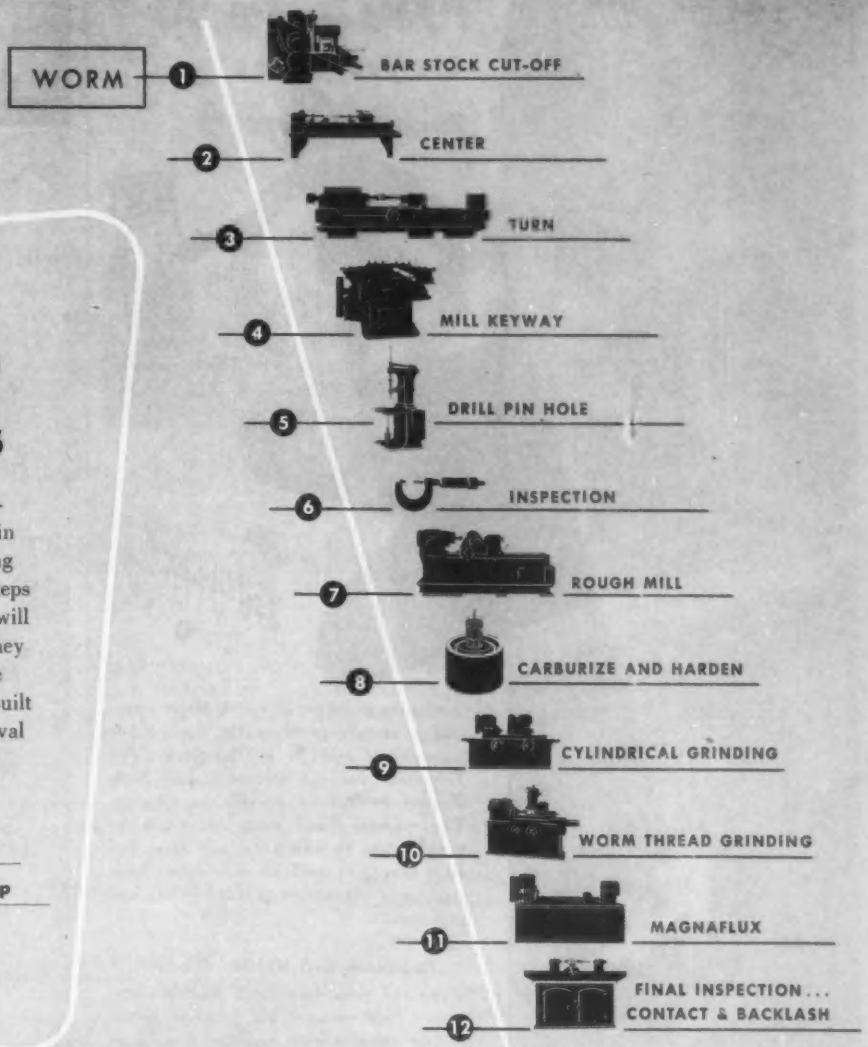

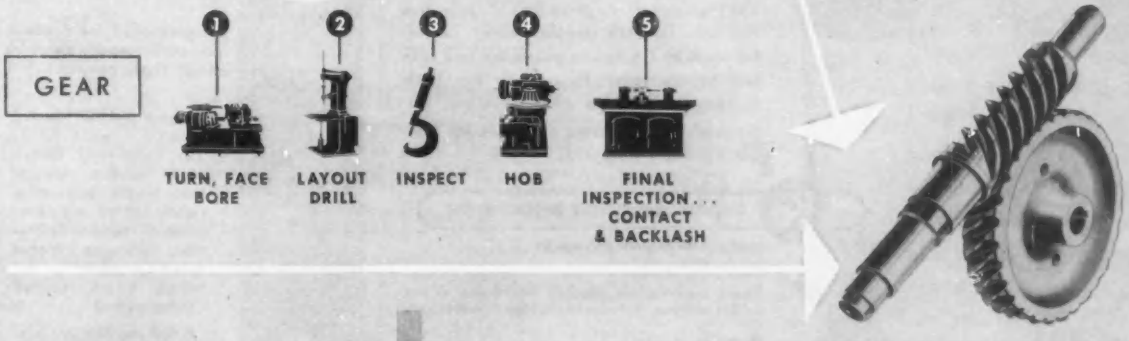

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DE LAVAL STEAM TURBINE COMPANY
801 Nottingham Way, Trenton 2, New Jersey

DL-239

Roth Rubber Solves Rubber Problem for West Coast Manufacturer!

A viewing hood for an oscilloscope seems like a simple problem for the rubber technologist, yet it is significant that Tektronix Inc., of Portland, had Roth Rubber, in Chicago, provide the solution. The viewing hood must not crack or buckle, has to adjust to any face and must exactly fit the Tektronix scope. Roth engineers solved this problem—they can solve *yours*.

Engineers and Rubber Buyers!

Write for your free Roth Rubber sampler. This unusual kit contains actual rubber samples with hardness from 5 to 100 Durometer . . . gives ASTM specs and lists uses for each sample. Sorry, but offer must be limited to engineers and rubber buyers only. Please ask for Roth Rubber Sampler No. PE4.

Custom Manufacturers of Industrial Rubber Products since 1923.

Request Roth's Counsel—NOW!

Get Roth technical assistance without obligation. We'll be glad to help you solve your rubber problem. Write or mail coupon today.

ROTH RUBBER COMPANY

1856 S. 54th Avenue, Chicago 50

Send Roth Manual

Please comment on attached description of our rubber problem or production rubber requirements.

Name_____

Position_____

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City_____ Zone___ State_____

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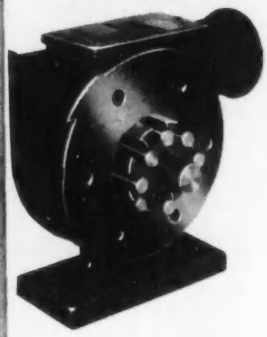
Primary Oil Pumps • Vacuum Powered Transmission and Low Pressure Air Service • Air and Liquid Filters •

What's your problem?

- ✓ higher pumping speeds?
- ✓ tolerance of particle-laden liquids?
- ✓ peak suction for primary pumps?



the Kraissl-50 Roller Pump

is unmatched for dependable performance on every one of those counts.

Bulletin A-1330 has full data . . . write for it. The roller-rotor design easily handles particles that would jam more tightly-fitted mechanisms — reduces cavitation, allowing higher speed operation* — develops high suction characteristics.

**Roller mechanisms permit higher speeds with any oil than most displacement designs.*

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Make Office Photocopies in Brighter Light on Peerless DRI-STAT *"Bright-Light" Paper*

NEW DRI-STAT "Bright-Light" paper offers, for the first time, office photocopying that truly deserves the name. Developed by Peerless Photo Products, Inc., DRI-STAT "Bright-Light" paper allows you to make sharp, clear, black-and-white photocopies of any original, under the normal levels of illumination in today's modern offices . . . fluorescent or incandescent light of fairly high intensity, or subdued daylight. Here, at last, is a paper that will give you good results under four to five times more light than you could ever work in before.

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You can copy originals up to 11″ by 17″ in size on DRI-STAT equipment, or continuous strip matter up to 12″ wide. Results are equally good from opaque or translucent originals, since copying can be done either by the reflex or the contact method.

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We do not manufacture stock gears. But once *your* specifications are in our files, re-orders are filled promptly—*and delivered on time*. We are equipped to produce gears in any quantity, any type, any material, metallic or non-metallic.

Let us present our conception of a modern and *mutually* advantageous gear engineering service. No obligation of course.

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PERKINS MAKES: helical gears, bevel gears, sprockets, ratchets, worm gears, spiral gears, spur gears with shaved or ground teeth, ground thread worms.

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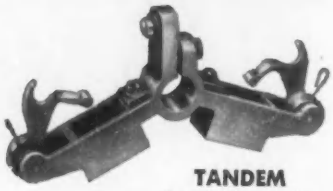
PERKINS
MACHINE & GEAR COMPANY
WEST SPRINGFIELD, MASSACHUSETTS

MAXIMUM
motor and
generator
PERFORMANCE
with

FLOWER
BRUSH HOLDERS



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TYPE 85-SK
for stationary motors and generators

There's a reason for the claim: "maximum motor and generator performance" — long life for both Brush Holders and Brushes is built into the units with highest quality bronze castings, precision machining — proper designing.

Known throughout industry for their enduring qualities, some of these units have lasted more than 24 years, under critical operating conditions. High resistance to vibration and wear assures you, your FLOWER BRUSH HOLDER will not cause breakdowns in production.

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Flame-Plating may be the answer

Flame-Plating is a revolutionary LINDE process for applying a thin coating of tungsten carbide on the wearing surfaces of parts and many tools where extra wear-resistant qualities are needed. The Flame-Plated coating may be ground to a mirror-smooth finish for precision work, left in "as-coated" condition (similar to fine emery paper), or just hand polished where close tolerances are not required.

REDUCE REPLACEMENT COSTS

Flame-Plating gives added service life to parts and many tools that are subjected to wear. Service records of 10 and 20 to 1 over alloy and chromium plated steels are not uncommon. Replacement and machine down-time costs are thus greatly reduced.

HARDNESS WITH TOUGHNESS

Flame-Plated coatings have the inherent hardness and wear-resistance of tungsten carbide. Yet, when applied to a tough base metal, they will absorb a moderate amount of deformation without cracking under stress or mechanical shock.

MOST PARTS AND METALS CAN BE FLAME-PLATED

Practically all commercial metals including titanium can be Flame-Plated making possible unique combinations of qualities such as high wear-resistance with light weight or toughness. Typical Flame-Plating applications include automatic machine parts, bearings, bushings, core rods, plug and ring gages, shaft seals, and arbors.

For the full story on how you can solve wear problems with Flame-Plating, send for your free copy of the "Flame-Plating" booklet today. Just clip coupon.

Linde
TRADE-MARK

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A Division of Union Carbide and Carbon Corporation
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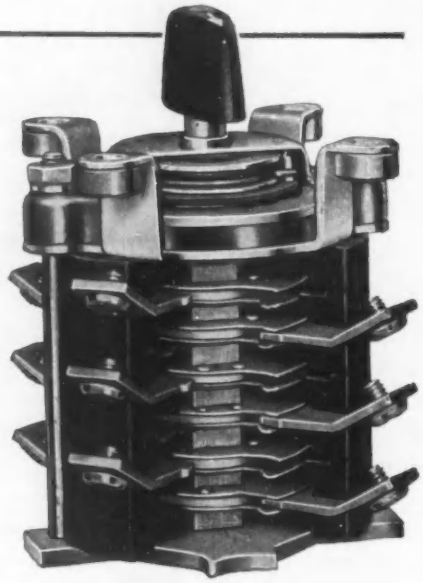


30-AMPERE TYPE-P ROTARY SNAP SWITCH

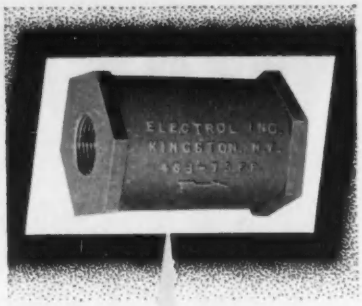
In all ESCO rotary switches, the make and break actions occur inside the insulating phenolic housings of the separate switch sections. These sections are ganged to provide the required number of poles.

Advantages: ESCO rotary switches combine great versatility of application with simplicity and ruggedness of design. In each individual switch section, a variety of rotor shapes and positions is possible. By ganging the required number of such sections, an almost unlimited choice of connection and operating sequence arrangements is available.

Ratings: The Type-JR rotary switch is rated at 10 amperes, 125 volts AC, or 5 amperes, 125 volts DC. The Type-P rotary switch — a high-speed snap-action switch — is available in these same ratings, and also in heavier designs for 30, 60, 100, or 200 amperes at 500 volts AC or 250 volts DC.

ESCO rotary switches can be furnished to meet the latest revised specifications of the Navy Department.

ELECTRO SWITCH
CORPORATION
167 King Avenue, Weymouth 88, Mass.



Electrol
Check Valves

Prevent Reversal of Flow in { **AIR . . . OIL OR WATER APPLICATIONS**

Electrol (463FP) Check Valves are ideally suited for heavy-duty service applications—providing positive sealing against return flow in air . . . oil . . . or water control lines, with a minimum of pressure drop. They have a maximum operating pressure of 5,000 P. S. I., with a cracking pressure — in free flow direction —from 2 to 8 P. S. I. Elements are of brass and bronze — and include an O-ring check seat. Sizes range from ⅛" to 2" N.P.T. Your inquiries will receive prompt attention.

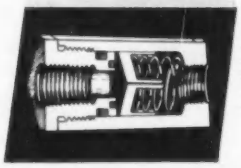


Diagram showing internal construction of the Electrol (463FP) Check Valve.

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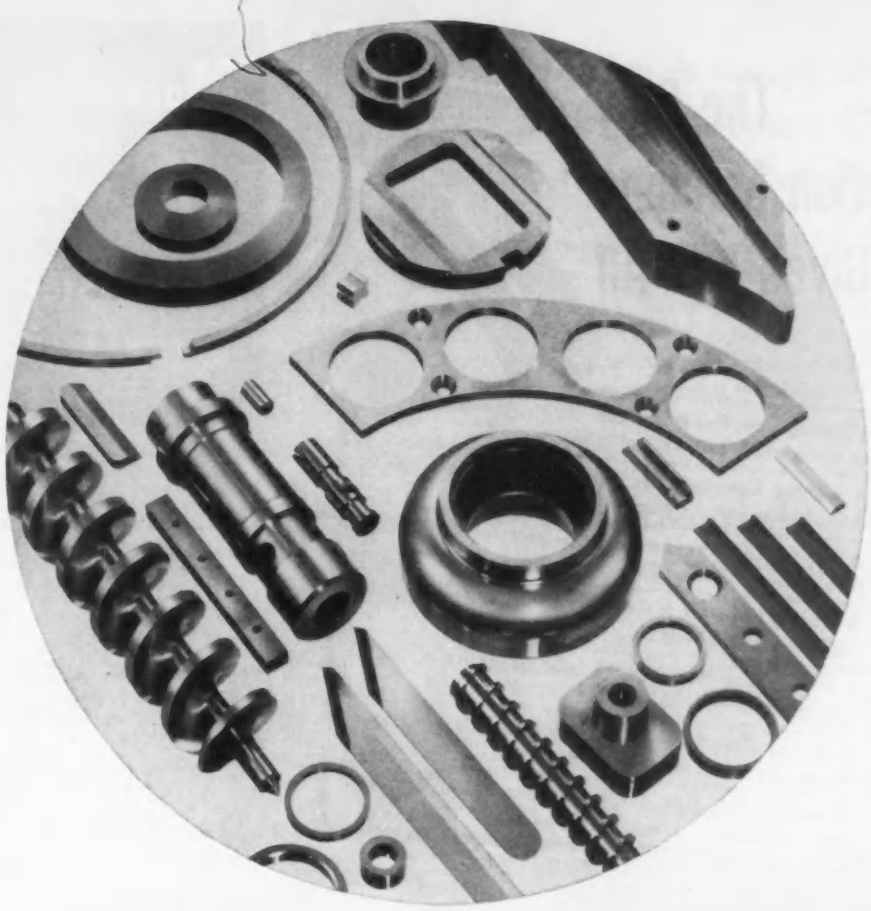

Some typical parts produced from HAYNES *alloys*

Custom Tailored to cut maintenance costs

Alloys for Every Wear Condition Shaped to Your Specifications

HAYNES alloys are available in a wide range of properties. They can be supplied as castings, forgings, stampings, or fabricated parts finished to close tolerances and with a mirror-like finish where required.

Some HAYNES alloys are extremely hard—to resist severe abrasion. Some are tough and ductile, designed for use where mechanical shock or repeated stress cause ordinary metal parts to crack and splinter. Some resist the corrosive action of acids, alkalies, and molten metals. Erosion from steam or liquids, the softening effects of high-temperatures, seizing and galling from metal to metal contact, are other severe conditions that can be effectively controlled through the use of HAYNES alloys.

Send us a blueprint of one of your wearing parts and tell us about the conditions under which the part must operate. We are sure we can supply you with a HAYNES alloy part "custom tailored" to solve your problem.

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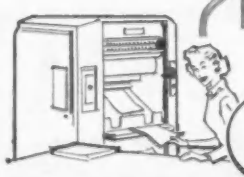

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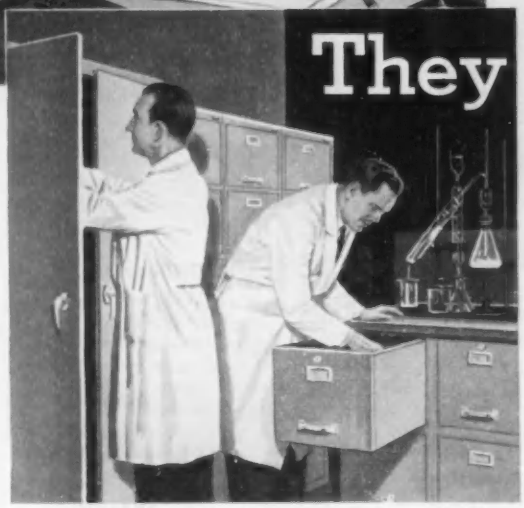
DETROIT 16

had to have access to 8 cabinets, 64 desks, 84 lockers, 17 closets and 18 rooms...*with just one key!*

Quite a demand the headmaster of an Eastern military academy made of the company from which he ordered that equipment. But he had the right idea. Why bother with hundreds of keys, if just one master key can control all of the locks. What's more, it would be less costly in the long run and less confusing, too.



needed private entrance to their individual desks and lockers

So that each student's key would open his particular desk or locker and nobody else's . . . while the headmaster's key would open them all.

No wonder the company filling the order immediately thought of Yale. For Yale not only makes a wide variety of locks, but is the world-leader in Master Keying Systems.

A wire to the Yale Lock and Hardware Division at Stamford, Connecticut soon brought a Yale representative to his office and a solution was quickly reached.

And so Yale proved to *another* manufacturer that no lock problem is too tough... too varied...too small for a happy solution

WHAT IS YOUR LOCK PROBLEM? No matter what it is, you owe it to yourself—and your customers—to find out what answer Yale has for you. Yale has competent industrial lock experts in major markets across the country and the chance is good that one may be in the vicinity of your office now. He has at hand the full details about all Yale locks, interesting data on how we solve tricky locking problems, and, of course, he is ready and anxious to show you that Yale can't be beat for Service, Security and Price. Write to our Industrial Lock Dept., The Yale & Towne Mfg. Co., Lock & Hardware Div., Stamford, Conn.

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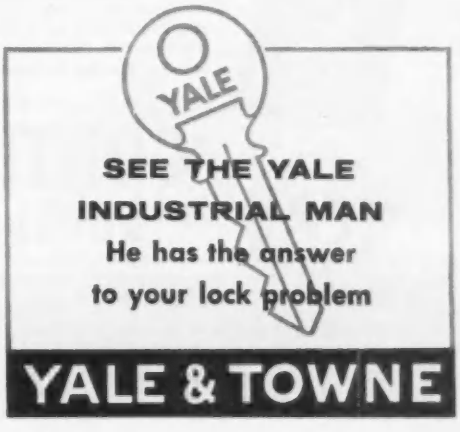

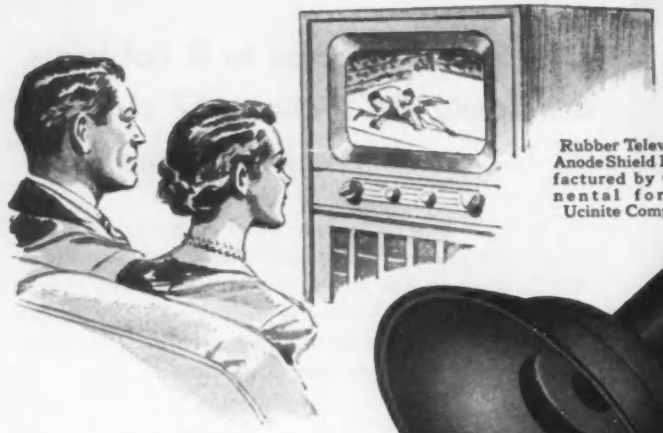

Rubber Television Anode Shield Manufactured by Continental for the Ucinite Company

Behind your ⇨ television screen . . .

Continental Rubber gets into the act

In the unseen act behind your television screen, a small cup-shaped rubber shield plays an important role. This shield fits over the anode on the side of the tube. Its function is to "seal in" high voltage current and thus prevent surface discharges that cause picture distortion.

Ordinary rubber compounds, of course, can't fill the bill. *This* rubber part must have exceptional dielectric properties and unusual stability under sustained heat. It must resist the deteriorating effects of ozone created by electrical discharges. In addition, the rubber shield must be precision molded to insure proper seating against the side of the television tube.

Continental engineers, working closely with Ucinite Company engineers, have met these exacting requirements. This technical cooperation typifies the service in rubber offered by Continental.

When *you* need better engineered rubber parts, why not enlist the service of specialists in molded and extruded rubber?

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This new engineering catalog lists hundreds of standard grommets, bushings, rings and extruded shapes. It will be a valuable addition to your working file. Send for your copy today or . . .

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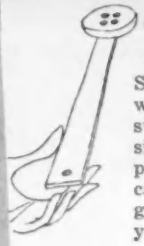
How to whip your relay problems!

Just call **ADVANCE...** *we're ready and willing to make the relays you need.*



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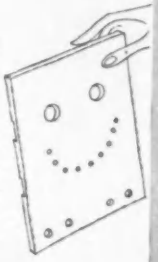

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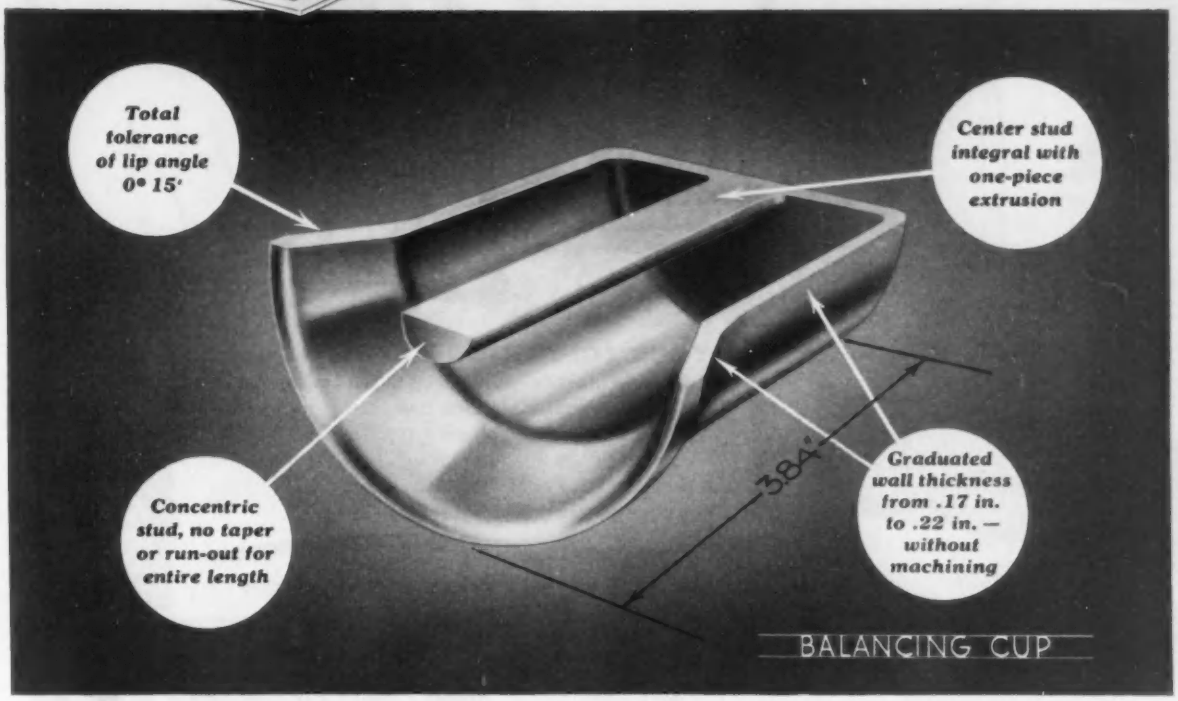
Now ***Mullins Koldflo*** *makes your dream design* ***practical***


Total tolerance of lip angle 0° 15'
Center stud integral with one-piece extrusion
Concentric stud, no taper or run-out for entire length
3.84"
Graduated wall thickness from .17 in. to .22 in. — without machining
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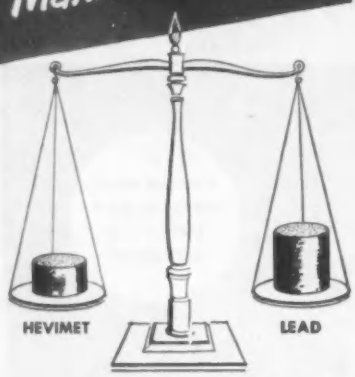
For Maximum Weight



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Hevimet can be easily machined with ordinary carbide tools, and joined by silver or copper brazing. Carboloy Hevimet is now available in two grades, of varying tensile strengths, finished or semifinished. Send coupon, today, for new Hevimet Technical Report.

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FOR THOSE
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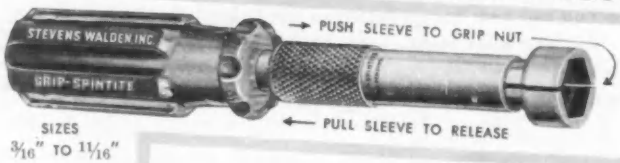

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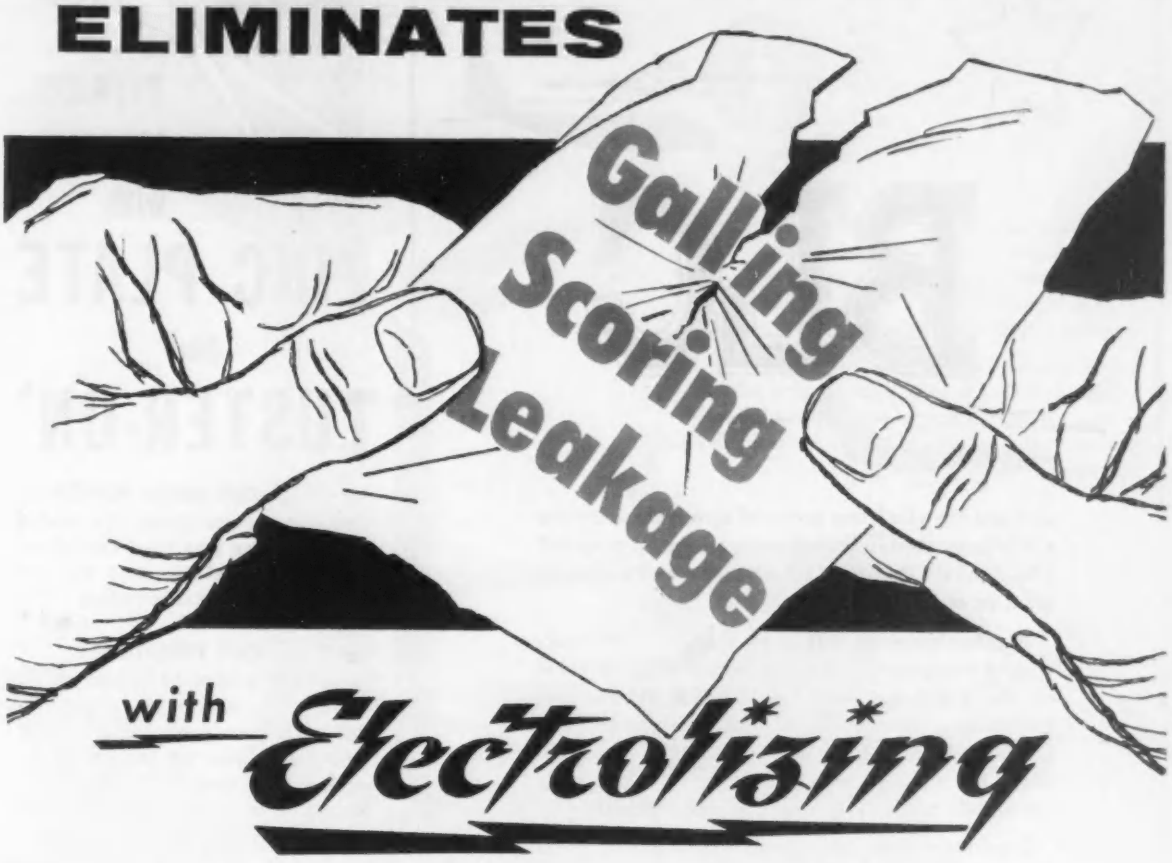

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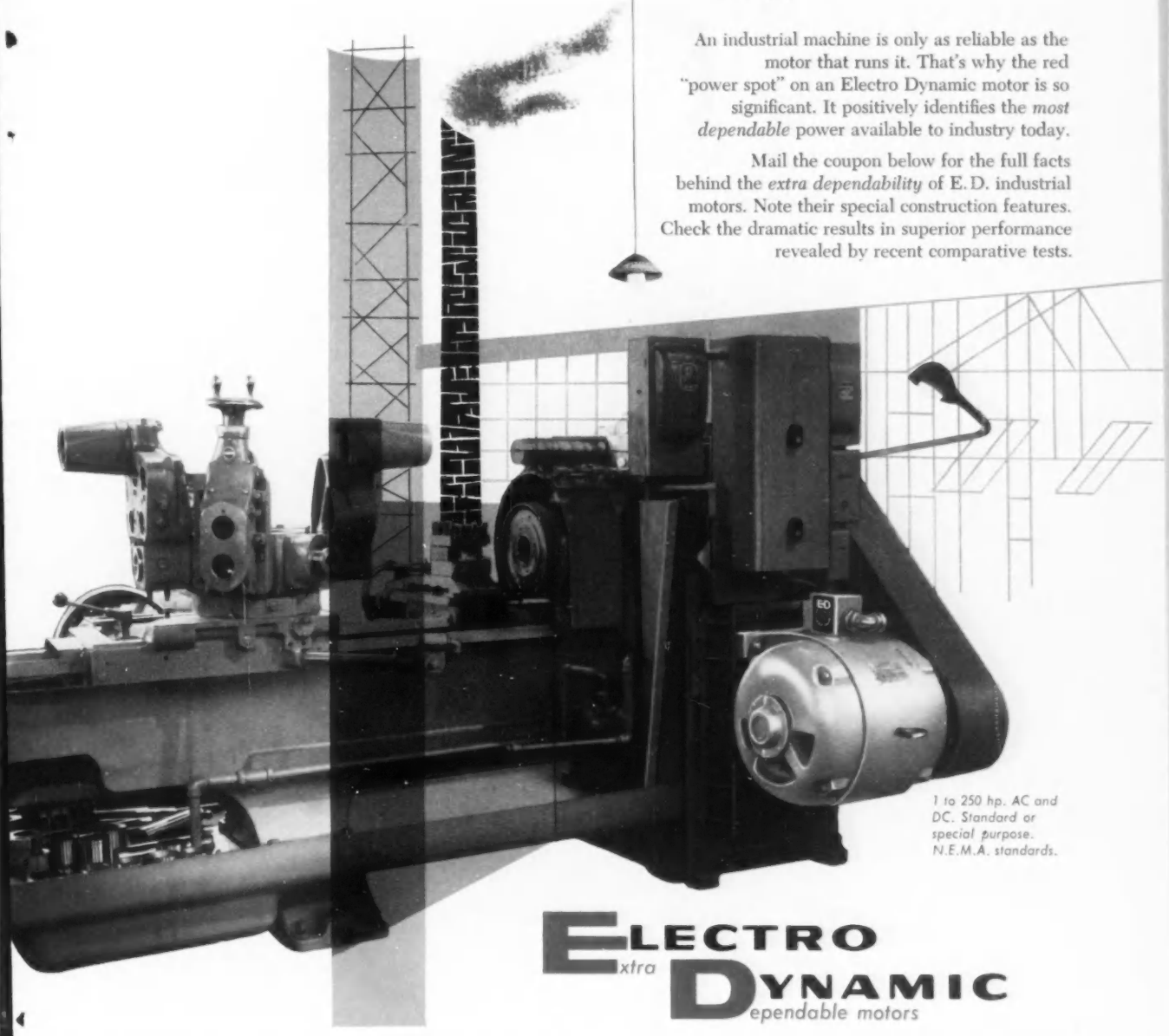

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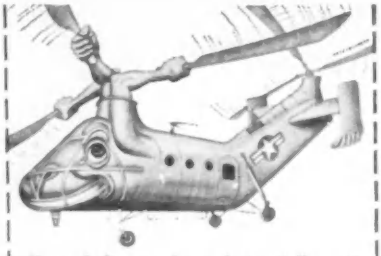

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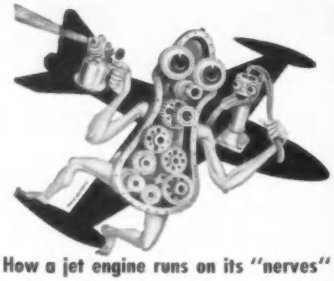

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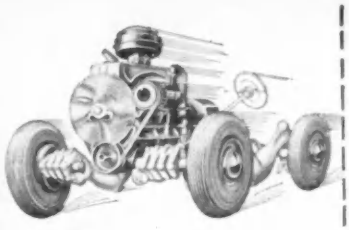

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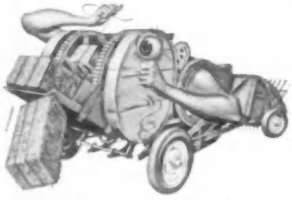

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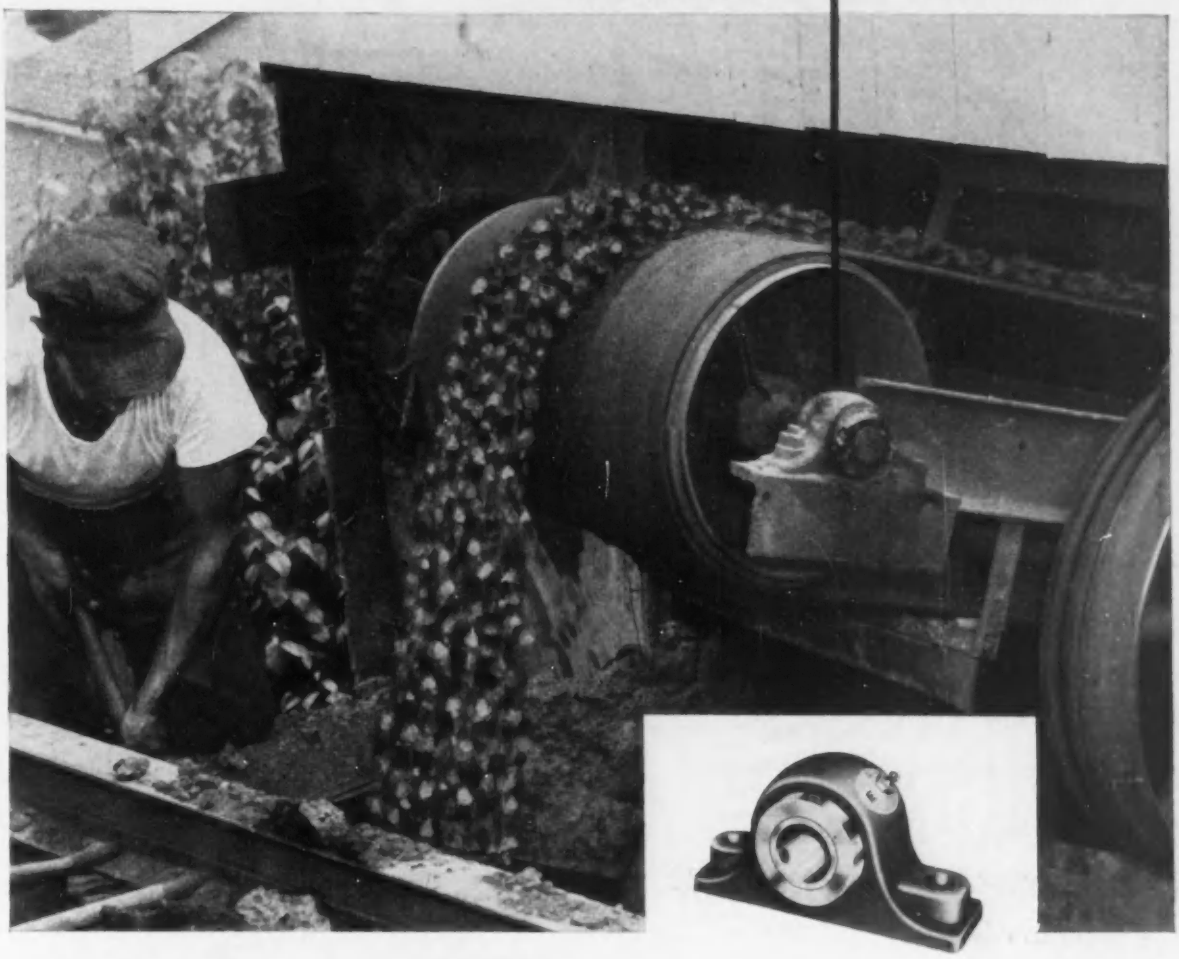

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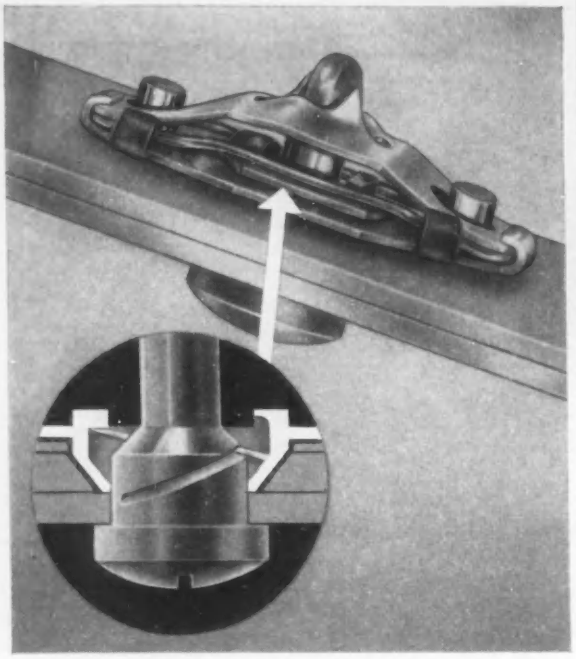

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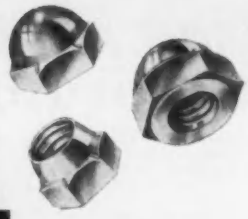

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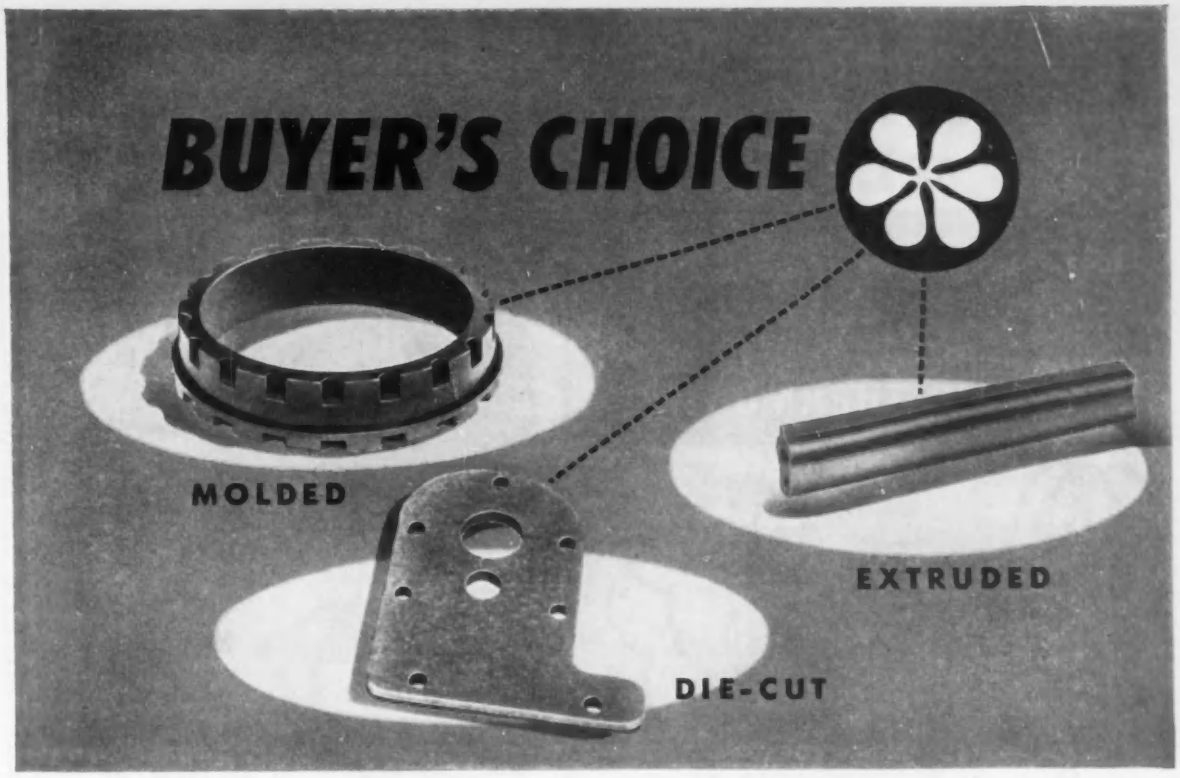

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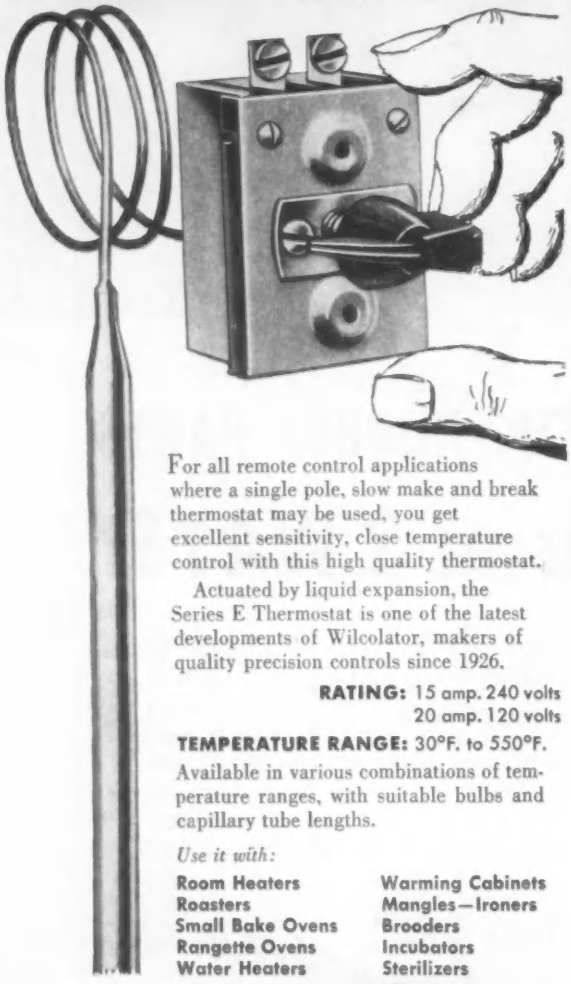

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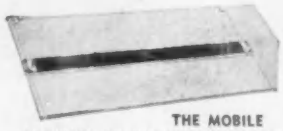

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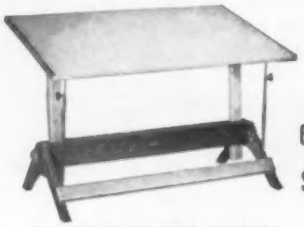

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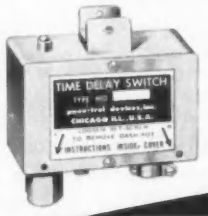
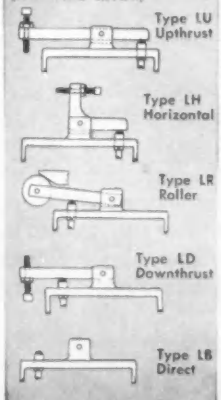


For Any Type Actuation Left or Right Hand (Left Hand Shown)



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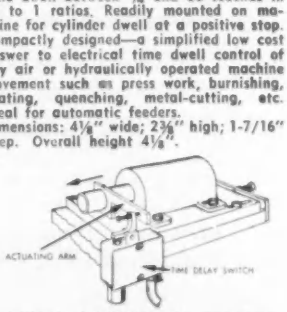

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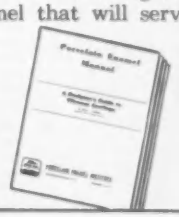

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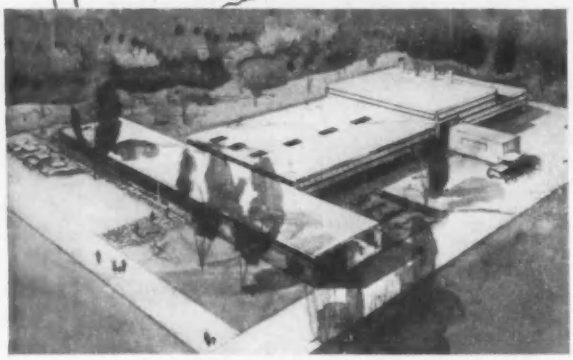

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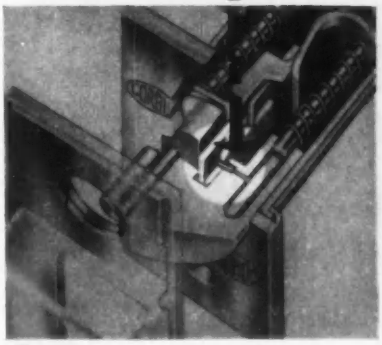
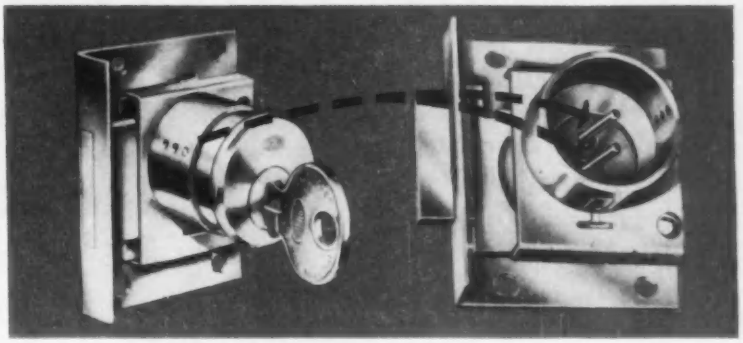


1 New Corbin "Defender" lockset has latchbolt designed around hidden Spirol pin fastening. Pin holds in place with only 1/16" engaged at each end. Bolt tail rides on exposed 1/8" center portion of pin. Spirol's radial tension locks pin in place, prevents it riding into track of plunger bolt.



2 Three interchangeable cylinders make the revolutionary new Corbin "Adapta-Lock" adjustable to six different thicknesses of wood or metal. Headed Spirol pins hold any of the cylinder plugs firmly in barrel, yet allow easy adjustment to 3 positions. Spirol pins were substituted for solid pins when tests on models proved that their unique coil construction not only locked them securely into the cam, but also gave them greater shear strength. Even at maximum depth where pins project only 9/32" into cylinder, Spirol pins hold rigid, assure perfect tumbler contacts.

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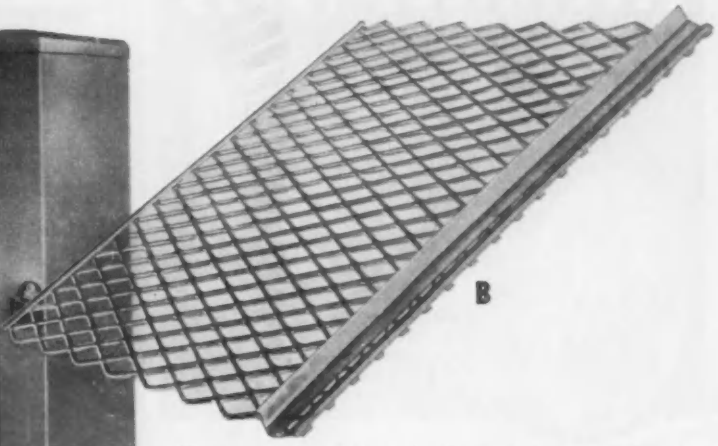

A "Precision-Thelco" incubator with doors opened, showing expanded metal shelves. A product of Precision Scientific Company, Chicago, Ill.

B Expanded metal shelf with bracket attached for use in a "Precision-Thelco" economy incubator.

C Blue M counter flow combination temperature and humidity cabinet with expanded stainless steel shelves. Manufactured by Blue M Electric Company, Chicago, Ill.

There are six reasons why Penmetal expanded metal is used for the shelves in these laboratory cabinets:

because it provides strong and rigid support for specimens or instruments.

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because it is available in stainless steel to match the construction of the cabinets.

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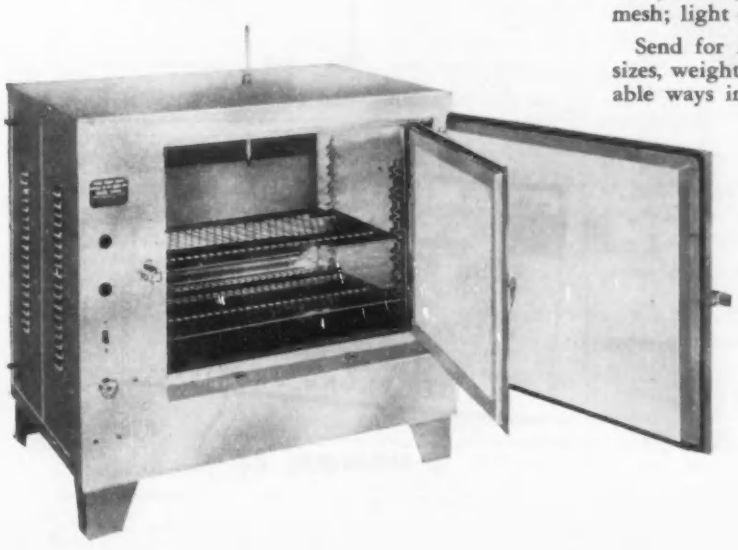

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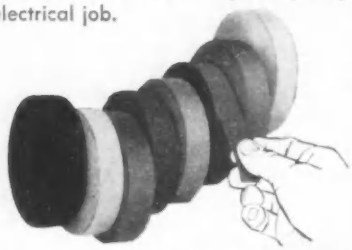

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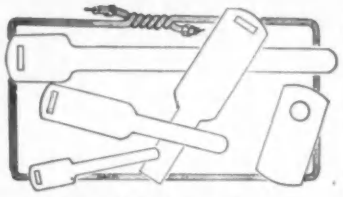

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The Lightning Rod . . . The Airplane . . . Penicillin
The Incandescent Lamp . . . The Combine and Harvester

FACT AND FANCY

1. Benjamin Franklin invented the lightning rod. But on September 27, 1947, Radio Moscow credited a Comrade Professor Lomonosov with the invention.

2. The Wright Brothers invented the airplane. But on January 16, 1949, Russia claimed one Comrade Mozhaisky invented it 25 years earlier.

3. Sir Arthur Fleming, an Englishman, discovered penicillin. But on January 7, 1947, Radio Moscow said that an unidentified Comrade invented it 50 years earlier.

4. Thomas Edison invented the incandescent lamp. But in 1945 Moscow contradicted its own Great Soviet Encyclopedia, which credits Edison, and named Comrade Ladygin as the inventor of the lamp.

5. Cyrus H. McCormick invented the combine and harvester. But *Pravda* said on June 7, 1953, that a Comrade Vlasenko invented one "twenty times better eleven years earlier."

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SPIN-LOCK holds tighter under vibration than ordinary fasteners. Ratchet-like teeth under the head lock into the surface when assembled. Hex, pan, truss, flat heads.

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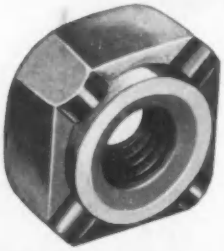

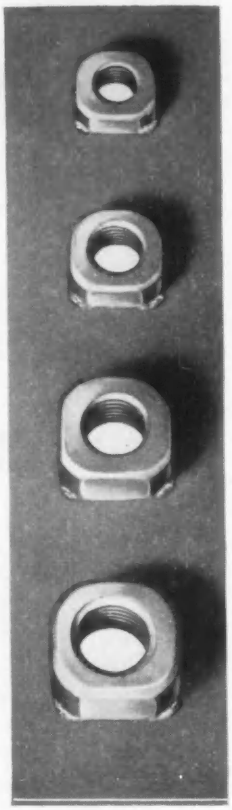

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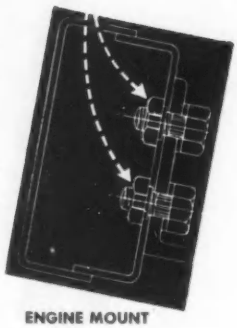

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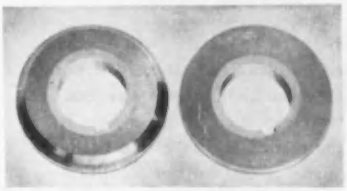
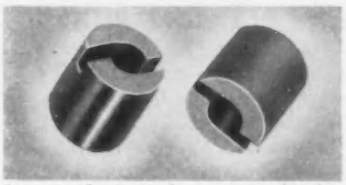
In the processing industries...

REDUCE COSTLY WEAR

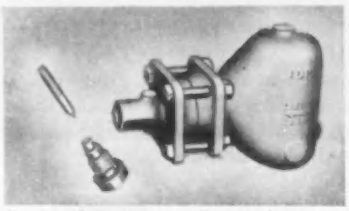
with Carboloy® cemented carbides



Dies for the extrusion or pill pressing of highly abrasive ceramics, pharmaceuticals or powdered metals, equipped with Carboloy cemented carbide, remained on the job many times longer than any other material.



In one plant, steel spray nozzles for homogenizing and dehydrating food products lasted 100 hours, due to the corrosive-abrasive action of the food products. Then Carboloy cemented carbide nozzles were used, and nozzle life increased to 3000 hours.



Steel valve stems and seats in a refrigerator regulating valve were quickly corroded and worn by ammonia. To resist this, inserts of Carboloy cemented carbide were substituted. Valve life increased 5 to 6 times.

WHERE ACIDS, alkalis, heat, oxidation and the like reduce equipment life, you can slow down wear, reduce maintenance costs, increase production and improve product quality with Carboloy cemented carbides.

The Carboloy organization manufactures cemented carbides in standard stock items, or designs them to your specifications for spray nozzles, steam valves and orifices for processing foods, soaps and drugs. Plus countless other applications such as core pins for ceramic baking where friction, corrosion, erosion and abrasion must be resisted.

Ask your equipment manufacturer, or write us, about strategic parts made wear-resistant through use of Carboloy cemented carbides.

Put These Outstanding Characteristics To Work In *Your* Plant:

- High abrasion resistance
- High corrosion resistance
- High erosion resistance
- High heat resistance
- High impact strength
- High friction-wear resistance
- Nonmagnetic
- Light weight (where desired)

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DEPARTMENT OF GENERAL ELECTRIC COMPANY

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SETTING THE PACE FOR INDUSTRIAL PROGRESS

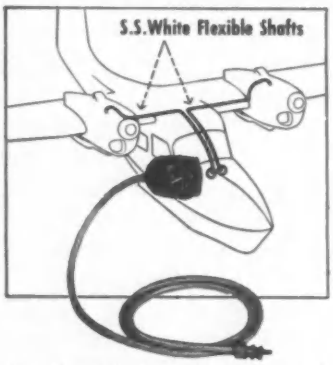
THE PROBLEM

FINDING AN ECONOMICAL WAY TO TRANSMIT POWER OVER LONG DISTANCES

In designing the instrumentation set-up for a small twin-engine amphibian plane, the engineers planned on using tachometers of the direct drive type. The problem of driving the tachometers was complicated by the fact that the engines were mounted on the wings at some distance from the point where the tachometers were to be installed. Intervening struts, frames and turns added further complications. The engineers found an answer in

THE LOW-COST SOLUTION

AN S.S.WHITE POWER DRIVE FLEXIBLE SHAFT



A single 11-foot power drive flexible shaft run between each tachometer and the power take-off on the corresponding engine did the trick. The flexibility of the shaft allowed it to be installed around the intervening obstructions, quickly, easily and economically. Operating at 2500 rpm, the shafts have given completely satisfactory service, according to the manufacturer. What's more, they can be readily removed and reinstalled whenever routine servicing becomes necessary.

This is one of many power drive applications in which S.S.White flexible shafts have brought about basic economies in design, in production and assembly. Why not consider their use on your own power drive applications?

The Design Engineers Bible

For full facts and data on how to select and apply flexible shafts, send for your free copy of the 256-page Flexible Shaft Handbook. Please write for it direct to us *on your business letterhead.*

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO.
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NEW YORK 16, N. Y.

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THE PROBLEM

DESIGNING FOR LOWER INSTALLATION COSTS

A design engineer wanted to incorporate a manually controlled trip odometer into an automobile speedometer assembly. When it came to designing the control linkage between the knob and the odometer, he was faced with the problem of selecting a method which would be economical both from the standpoint of materials and from the standpoint of easy installation. That's why he chose –

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AN S.S.WHITE REMOTE CONTROL FLEXIBLE SHAFT

The adaptability of the flexible shaft control allowed the speedometer to be properly positioned on the dashboard and the odometer reset knob to be placed where the user could readily operate it. Furthermore, the use of the shaft eliminated time-consuming alignment problems—*resulting in important savings in assembly time and costs* – and what is equally important, contributed to a design which adequately met customer acceptance.

It will pay *you* to investigate the cost-reducing possibilities of using S.S.White flexible shafts on your own remote control applications.

Here's Important Design Information

The 256-page Flexible Shaft Handbook has full details on how to select and apply flexible shafts. A copy will be sent free if you write for it direct to us *on your business letterhead.*

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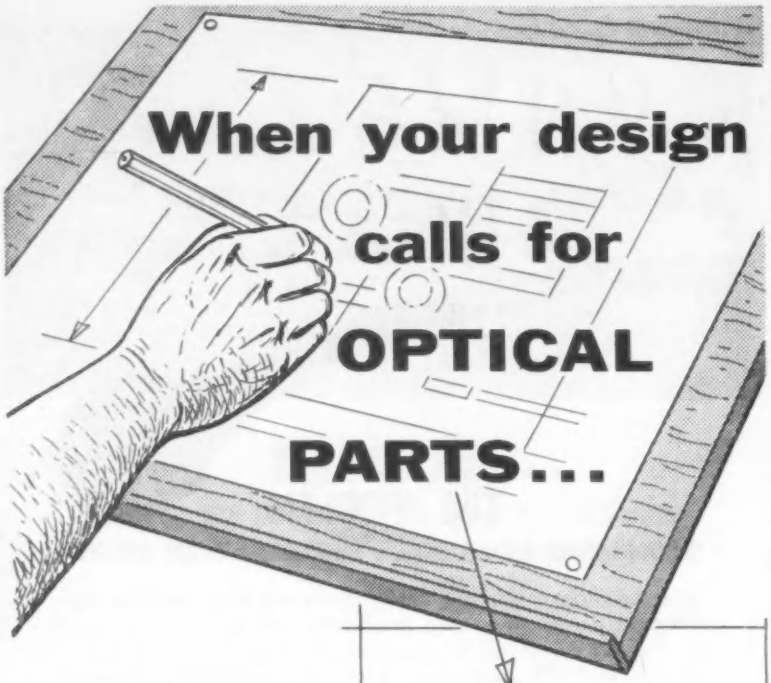

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Optical Parts

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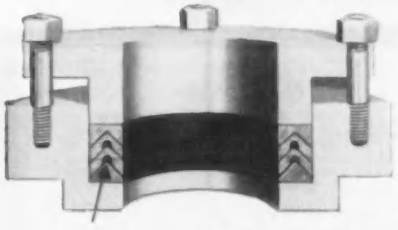
Why users prefer

CHEVRON* Packing

for rams, plungers, reciprocating rods

1. *Assures a low friction, positive seal*
2. *Lasts much longer, needs less maintenance than ordinary V-type packing*
3. *Works efficiently in a shallow stuffing box*



Note the exclusive hinge-like construction of CHEVRON packing.

Garlock 431 CHEVRON Packing

GARLOCK CHEVRON Packing is entirely different from ordinary V-type packings. With *increasing* pressures CHEVRON rings tighten and prevent leakage; with *decreasing* pressures the packing eases off and permits operation with a minimum of friction.

Service reports, such as those below, prove that CHEVRON packing seals better and lasts longer.

▶ On hydraulic press—40" ram, 6,000 p.s.i., ram honed and chrome plated, gland machined to give clearance of .006" between gland and ram. Garlock 431 CHEVRON size 40" x 41½" x only 2" deep gave 14 years service.

▶ On a machine with hydraulically operated clutches—¾" cylinder, maximum pressure 500 p.s.i., service intermittent, maximum travel ¾". First used cups, then "O" rings, neither of which worked well. Now packed with Garlock 431 CHEVRON ⅜" x ¾" x 17/32" deep and doing a smooth, positive sealing job.

Ask your Garlock representative to give you all the cost-saving facts about CHEVRON packing, or write for folder AD-115.

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Ruggedized and aged

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The "Reliable" version of the 2C51 and 5670

Do you have an aircraft or industrial application that requires *utmost* dependability in increasing or controlling alternating voltages or powers ... in changing electrical energy from one frequency to another . . . or in generating an alternating voltage?

If so, specify the Red Bank RETMA 6385 "Reliable" Double Triode. For it is specially ruggedized to perform at top efficiency longer, even under operating conditions of severe shock and vibration. And, as further assurance of its extra reliability, each RETMA 6385 is factory-aged with a 45-hour run-in under various overload, vibration and shock conditions, such as it might meet on the job.

Whether you need tubes as amplifiers, mixers, or oscillators, it will pay you to investigate the superior, longer-lasting performance qualities of the Bendix Red Bank RETMA 6385.

RATINGS*

Heater voltage—(AC or DC)**	6.3 volts
Heater current	0.5G amps.
Plate voltage—(max.)	360 volts
Max. peak plate current (per plate)	25 ma.
Max. plate dissipation (per plate)	1.5 watts
Max. peak grid voltage	+ 0 volts −100 volts
Max. heater-cathode voltage	300 volts
Max. grid resistance	1.0 megohm
Warm-up time	45 sec.

(Plate and heater voltage may be applied simultaneously.)

*To obtain greatest life expectancy from tube, avoid designs where the tube is subject to all maximum ratings simultaneously.

**Voltage should not fluctuate more than ±5%.

PHYSICAL CHARACTERISTICS

Base	Miniature button 9-pin
Bulb	T-6½
Max. over-all length	2¼ in.
Max. seated height	1 13/16 in.
Max. diameter	⅞ in.
Mounting position	Any
Max. bulb temp.	160° C

AVERAGE ELECTRICAL CHARACTERISTICS

Heater voltage, E_f	6.3 volts
Heater current, I_f	0.50 amps.
Plate voltage, E_b	150 volts
Grid voltage, E_c	−2.0 volts
Plate current, I_b	8.0 ma.
Mutual conductance, g_m	5000 μmhos
Amplification factor, μ	35
Cut-off voltage	−10 volts
Direct interelectrode capacitances (no shield)	
Plate-grid (per section)	1.7 μμf
Plate-cathode (per section)	1.1 μμf
Grid-cathode (per section)	2.4 μμf
Plate-plate	0.1 μμf

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Manufacturers of Special-Purpose Electron Tubes, Inverters, Dynamotors and Fractional HP D.C. Motors

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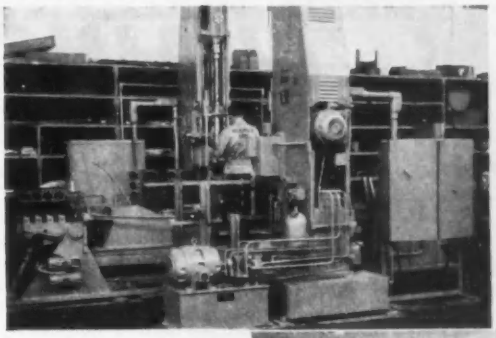

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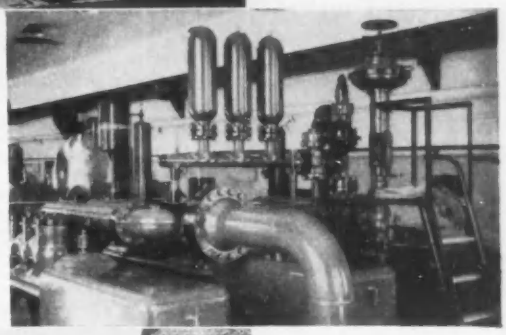

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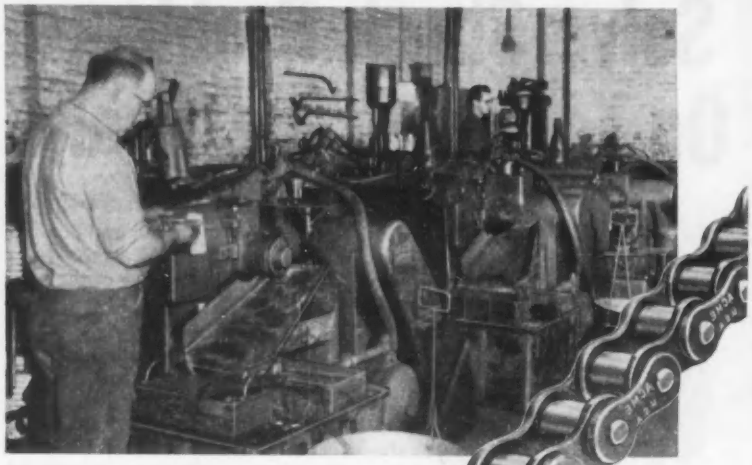

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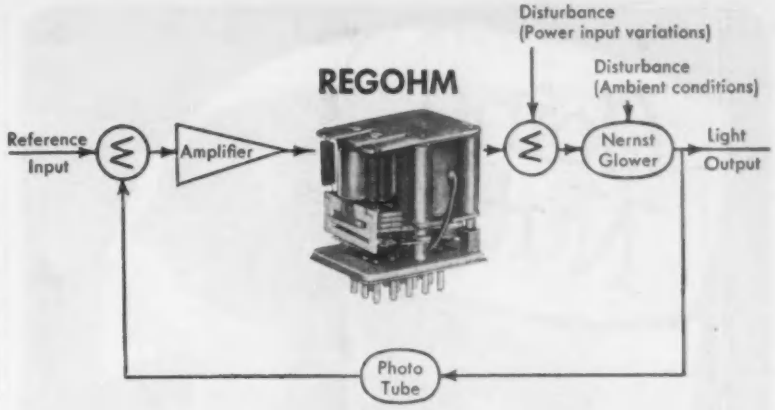

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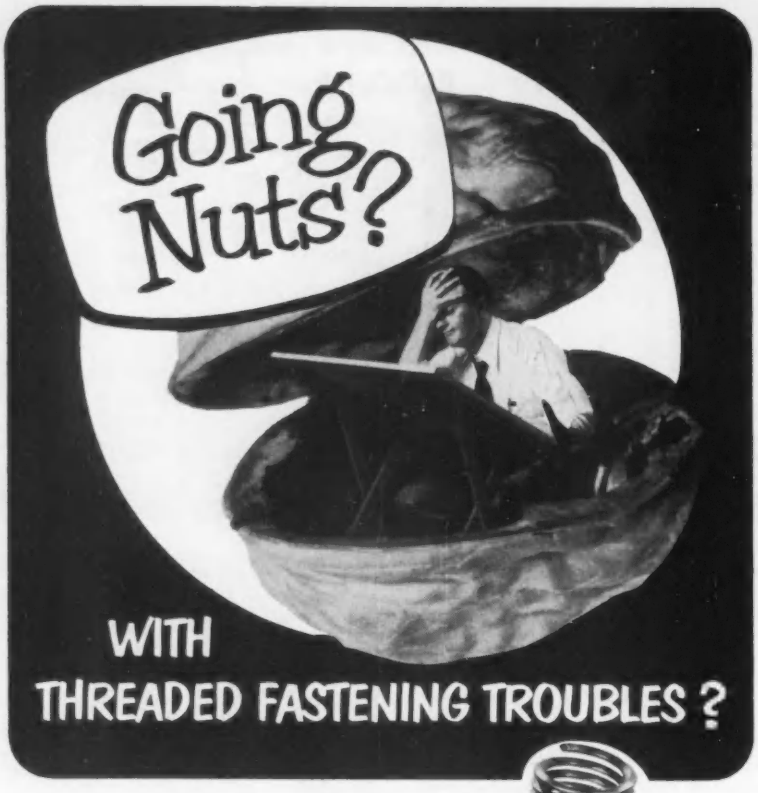

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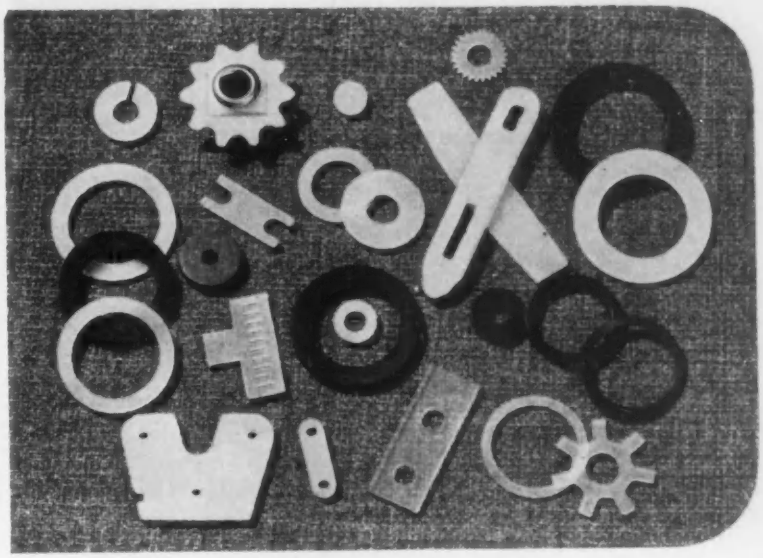

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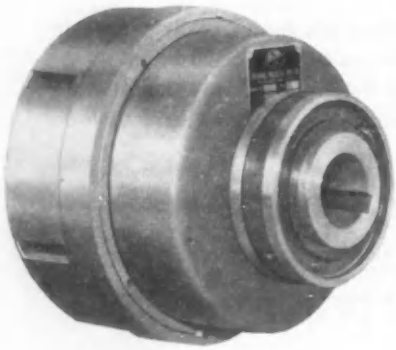
Make these Stearns advantages work for you:



WIDE TORQUE RANGE — .4 to 30,000 lb foot. Handles everything from business machines to steel mill screwdowns and ball and rod mill drives.

LOW INERTIA — Fast, smooth engagement and disengagement.

VARIED DESIGNS — Through shaft, split shaft, duplex for two speed drives, forward and reverse drives — other special applications.

WIDELY ADAPTABLE — DC or AC with rectifier. Automatic and remote control. Operates in conjunction with electronic circuits.

QUIET AND COOL RUNNING—Generous friction surface area and low unit pressure.

EASY WEAR ADJUSTMENT — Provides longer clutch life.

SIMPLE INSTALLATION — no toggles, yokes, shifters.

For full details consult your 1954 Sweet's Product Design file or write for Bulletin 226-C-3.

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MAGNETIC EQUIPMENT FOR ALL INDUSTRY

STEARNS MAGNETS

STEARNS MAGNETIC, INC., 631 S. 28th St., Milwaukee 46, Wis.

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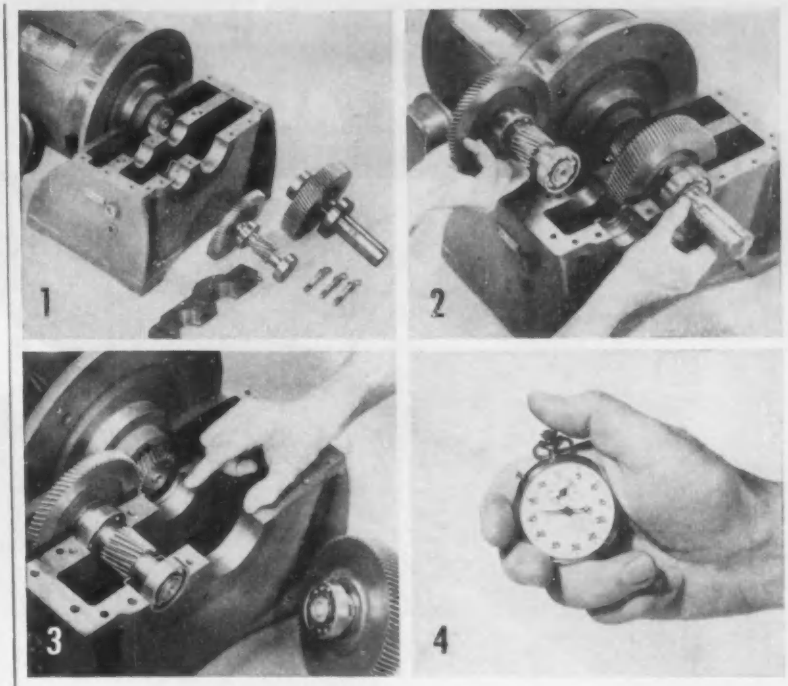


4 reasons why customers want Westinghouse Gearmotor Drive

Add sales points to your product. Westinghouse Gearmotors, with the exclusive horizontal split case, have many design advantages for you and your customers. Four such benefits are pictured above . . . here's the story behind each!

1. **Case cover quickly lifted** after removing a few bolts. No need to dismount motor, break coupling to driven load or drain oil! All servicing can be done in confined work area.
2. **No intricate subassemblies** exist in Westinghouse Gearmotors. Once case cover is removed, all gearing parts are free for removal. No further dismantling required for gearing maintenance.
3. **Firm bearing support** is assured. Bearings are anchored directly to case foundation, not in subassembly discs or spiders. Machined shoulders hold horizontal thrusts to exact tolerances . . . undue tooth wear and vibration are eliminated.
4. **4.78 minutes to dismantle** a Westinghouse Gearmotor! Each step of dismantling operation was "stop-watch timed". Included in study was time required for removal of end cap, motor, gears and pulling of pinion. Total time required . . . 4.78 minutes; a record that withstands any comparison!

Pass these advantages on to customers. Specify Westinghouse Gearmotors in your machine design. Write for free booklets—*Gearmotors* B-5645; *Speed Reducers* B-5646—to: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-07340

YOU CAN BE SURE...IF IT'S Westinghouse

THEY LOOK ALIKE

Cast rail and fabricated base assembly

One-piece Gray Iron rail

...but compare production costs!

GRAY IRON CHARACTERISTICS INCLUDE:

Castability
Strength
Rigidity
Low Notch Sensitivity
Wear Resistance
Heat Resistance
Corrosion Resistance
Durability
Vibration Absorption
Machinability

One-piece Gray Iron casting cuts machining and assembly steps

Still another manufacturer has found that one-piece Gray Iron castings lower production costs and improve product performance.

Shown above are two types of main rails along which an oxyacetylene shape cutting machine travels. One is a two-piece assembly . . . the other is all Gray Iron.

By redesigning as a one-piece Gray Iron casting, this manufacturer eliminated two machining operations and one assembly operation formerly required to make the fabricated rail. Because of the inherent dimensional stability and rigidity of Gray Iron, cutting accuracy of the machine is held to .015″ over the 12′ of travel.

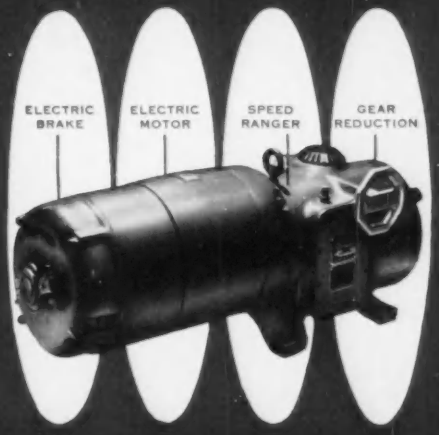
Have you taken a good look at the cost-saving and improved performance possibilities of redesigning your fabricated parts for Gray Iron casting? Why not let us help you—write for technical information on the many advantages of the Gray Iron casting process.

MAKE IT *BETTER* WITH GRAY IRON

***75%* of all cast metal products are Gray Iron**

GRAY IRON FOUNDERS' SOCIETY, INC.

NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO



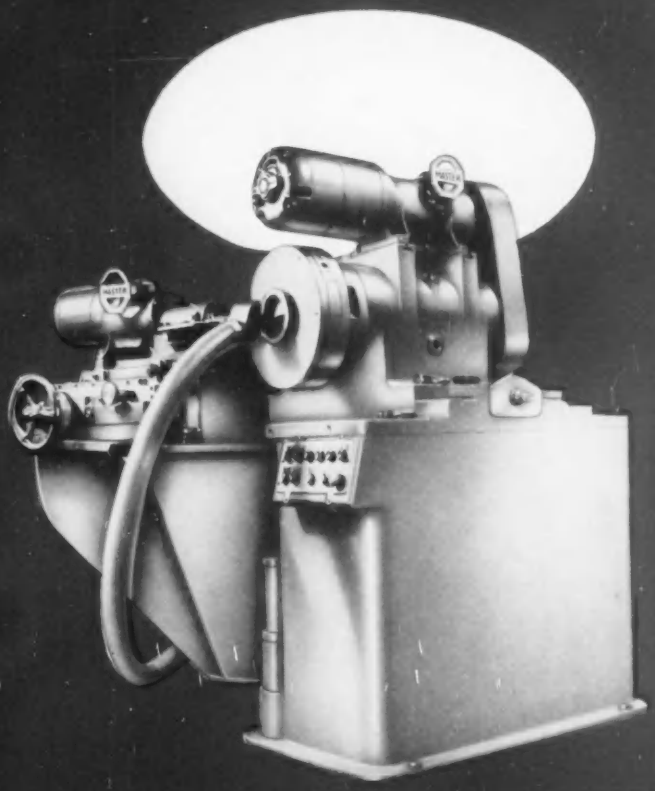
reason

The electric motor, the electric brake, the variable speed drive, the gear reduction unit . . . all are designed so that they easily combine into an integral power drive.

result

The RIGHT horsepower, the RIGHT shaft speed, the RIGHT features in one compact unit that you can use RIGHT where you want it. Only one unit to buy, handle and install . . . saves time, space and money.

Use Master power drives to increase the salability of your motor driven products . . . improve the economy, safety and productivity of your plant equipment. They're the horsesense way to use horsepower.



THE MASTER ELECTRIC COMPANY • DAYTON, OHIO

"Old reliable" 21 in. sliding head floor drill stays accurate *with spindle on TIMKEN® bearings*

THE long-lasting precision of this Cincinnati 21″ sliding head floor drill has earned it the nickname "Old Reliable". One reason for this precision: the spindle is mounted on Timken® tapered roller bearings which are supported in an accurately ground and graduated quill. Two tapered roller bearings support the quill and two support the spindle pulley.

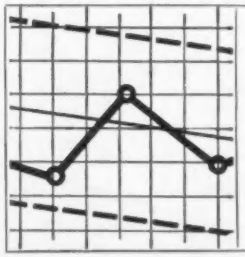
Timken precision bearings are especially designed for spindle applications. Run-out tolerances can be held to a maximum of 75 millionths of an inch. Due to their tapered construction, Timken bearings take both radial and thrust loads in any combinations, hold spindle rigid, permit pre-loading to any desired degree to prevent chatter.

Because of line contact between rollers and races, Timken bearings provide adequate capacity for any tool load. And spindle accuracy can always be maintained because Timken precision bearings are adjustable.

Timken bearings have contributed to the development of precision machine tools for over 25 years. To get longer life with minimum maintenance, buy or build machine tools that are Timken bearing equipped. Always look for the trade-mark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

CINCINNATI LATHE & TOOL CO. uses Timken precision bearings on the spindle of its 21″ sliding head floor drill to insure long lasting spindle precision.



STATISTICAL QUALITY CONTROL

To insure uniform high quality and closer tolerances, the Timken Company uses statistical quality control. With it, tolerance deviations are plotted graphically. It's one of industry's newest, most scientific methods of improving product uniformity.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ⇕ AND THRUST →|← LOADS OR ANY COMBINATION ✳